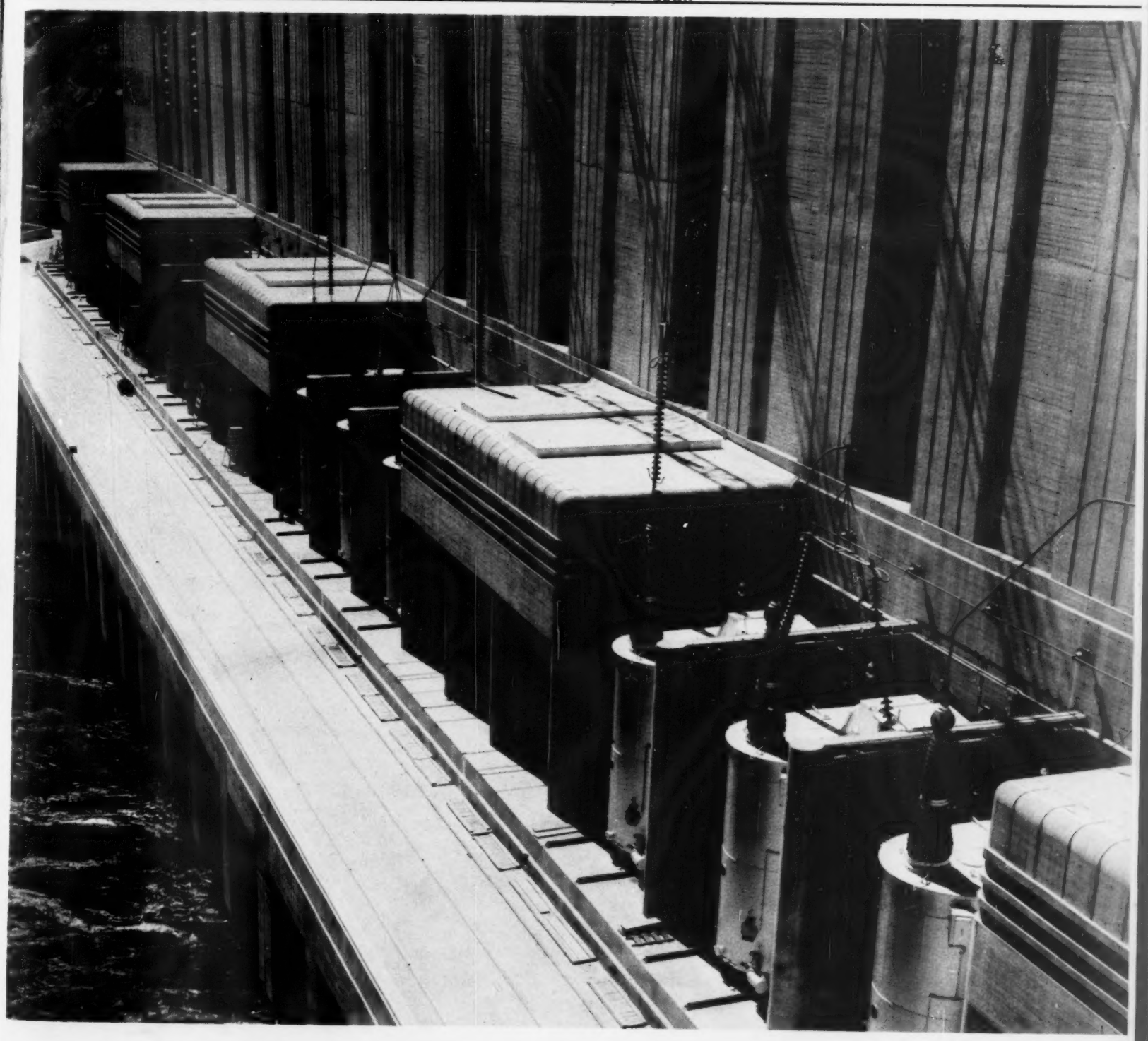
TECH ENGINEERING NEWS

Bureau of Standards
JAN 27 1939



JANUARY • 1939

vol 19, no 8

ECONOMY — WITH A MORAL

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OUR AUTHORS

DEAN ABNER FALES, associate professor of automotive engineering, is generally recognized as an authority in his field. Professor Fales has a leading position in the New England division of the S.A.E. and frequently speaks before that body and similar groups on modern trends in the automotive world. His article on the various aspects of the automobile of 1939 thus comes as the critical observations of a man who has been closely associated with the industry for many years.

Professor Fales graduated from the Institute in 1914. During the World War he was head of the Aeronautical Department of the United States Naval Detachment of the School Military Aeronautics. After the war he returned to the Institute, where he has been teaching mechanical engineering since 1922.

ROBERT SEATON WILLIAMS began the application of photography to the study of metals to make up for the absence of any textbook on the subject while working with Professor Tamman at Gottingen. Since then he has developed this process to cover intensive examination of metals, and his article this month deals with the topic of photomicrography. Graduating from the Institute in 1902, Professor Williams received his Ph.D. at Gottingen in 1907. After writing the first American textbook on general metallography, as well as several other papers and volumes, Professor Williams became Head of the Department of Metallography at Massachusetts Institute of Technology in 1927.

DR. LYMAN J. BRIGGS, who writes in this issue on the standardization of radio broadcast frequencies, is considered to be among the outstanding physicists of the United States. A native of Michigan, he attended Michigan State College, receiving his Bachelor's degree in 1893. He now holds degrees from the University of Michigan, Johns Hopkins University, South Dakota School of Mines, and George Washington University.

Director of the National Bureau of Standards since 1933, Dr. Briggs has been working for the Government almost continuously since he left college. He started as a physicist in the Bureau of Soils of the Department of Agriculture and in a few years was given charge of the biophysics investigations of the Bureau of Plant Industry. In 1920 he entered the Bureau of Standards, where he has remained ever since.

Dr. Briggs' rank as a scientist has also given him positions in a number of scientific institutions besides his own Bureau. Eminence in aeronautics has given him a seat on the National Advisory Committee for Aeronautics. A trustee of the National Geographic Society, he headed the advisory board for the record-breaking stratosphere balloon flight made by the Society and the United States Army in 1935.

FREDERICK SARGENT, member of the class of 1942, attended the Phillips Exeter Academy during 1935–38, where he was active in several scientific organizations and president of the Scientific Society. While in attendance at the Academy the author began his investigations in the field of meteorobiology. Last summer he studied under Dr. William F. Petersen, noted pathologist of the University of Illinois College of Medicine in Chicago. The author exhibited some of his investigations on the common cold and weather at the American Congress of Physical Therapy last September in Chicago. He has written two papers on the common cold, and in collaboration with Dr. A. J. Nedzel of the University of Illinois College of Medicine he has written a paper on the variations of the toxicity of morphine sulphate in rats as influenced by the weather. The author is a member of the American Association for the Advancement of Science.

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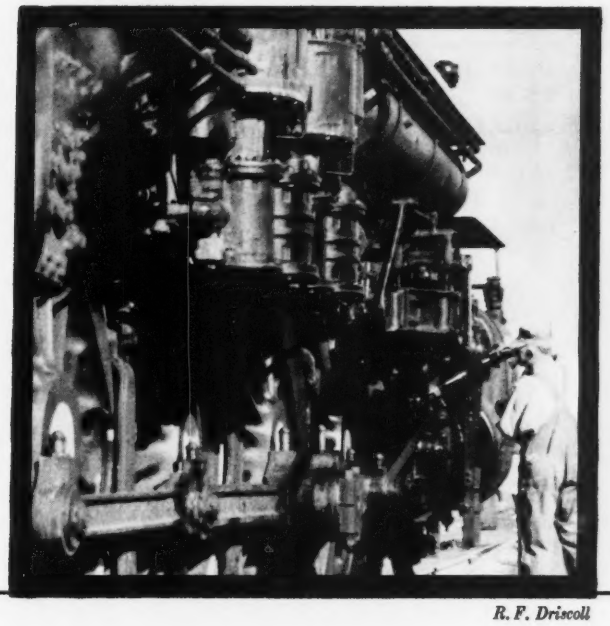

R. F. Driscoll

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OUR COVER THIS MONTH

The cover this month is from a photograph
by the United States Bureau of Reclamation

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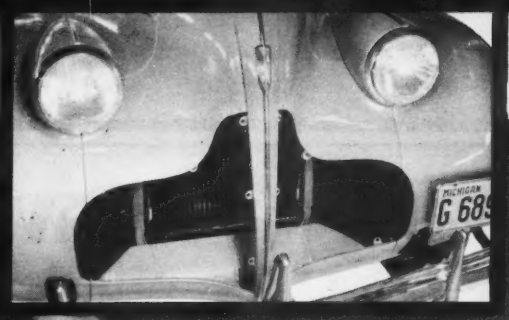
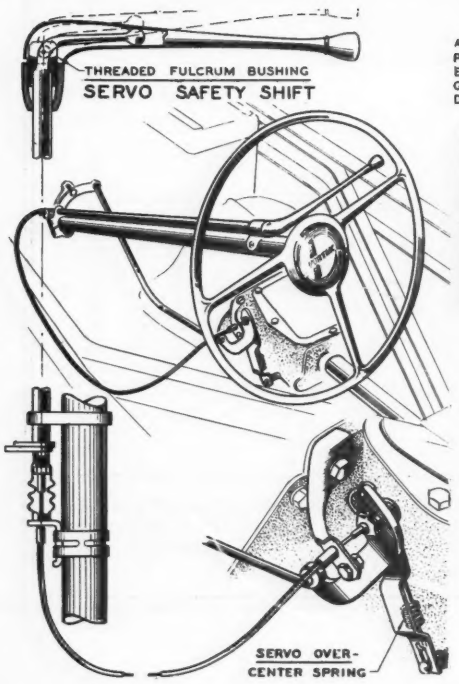
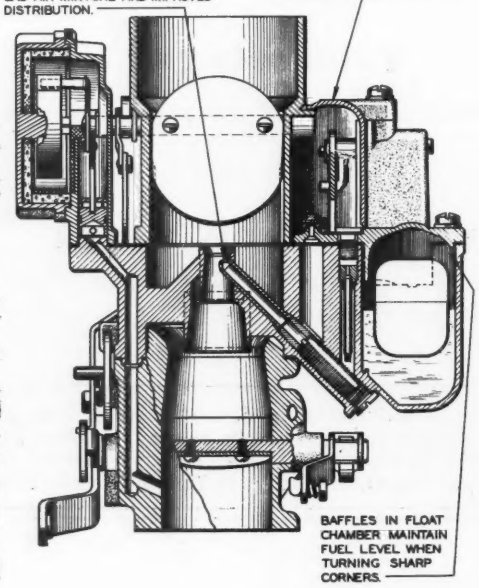
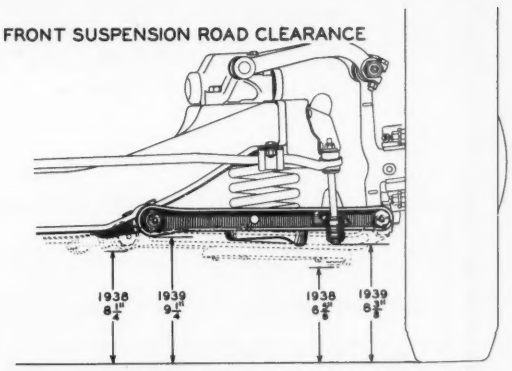




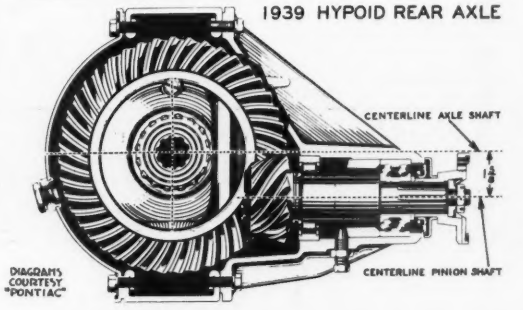
SECTION THRU 1939 CARBURETOR


AIR PASSAGE IN MAIN FUEL NOZZLE PROMOTES FORMATION OF FUEL EMULSION AFFORDING BETTER GAS-AIR MIXTURE AND IMPROVED DISTRIBUTION.
DIE CAST LINKAGE COVER PROVIDES BETTER PROTECTION FROM DUST.
BAFFLES IN FLOAT CHAMBER MAINTAIN FUEL LEVEL WHEN TURNING SHARP CORNERS.

FRONT SUSPENSION ROAD CLEARANCE



1939 HYPOID REAR AXLE



DIAGRAMS COURTESY "PONTIAC"

Automobiles of 1939

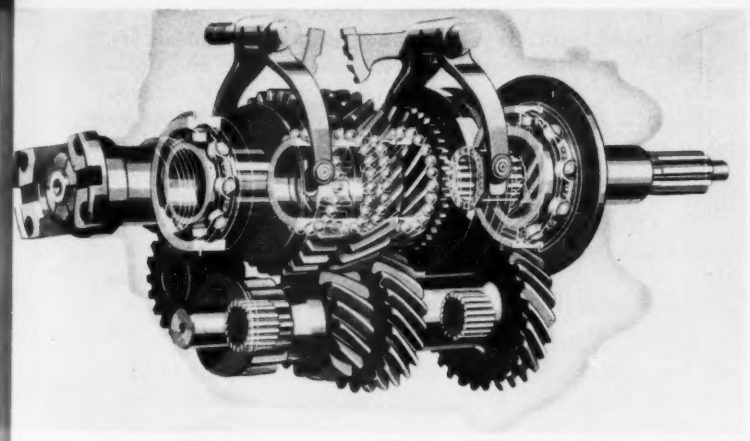
DEAN A. FALES

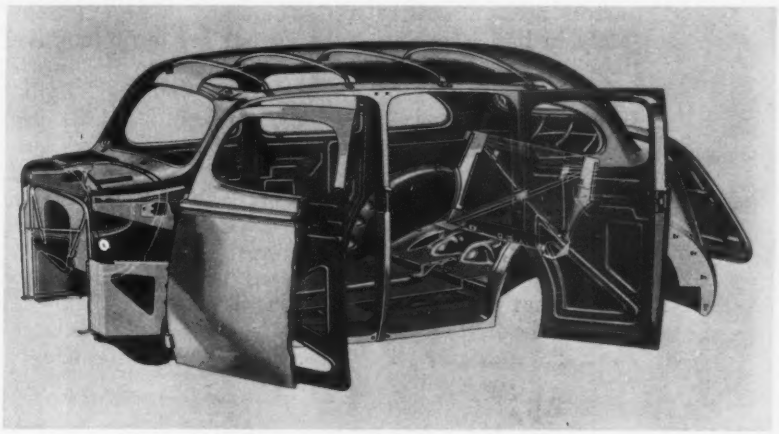
THE industry in which the United States now leads the productive forces of the world began forty years ago when the horseless carriage was first sold as a commercial product. Since then, the enthusiasm and tireless work of many ingenious mechanics have rapidly changed this bucking, single-cylindered, horseless carriage into the multicylindered, luxuriously appointed motor car of today. The automobiles, at that time, were reliable and could be driven over existing roads in all kinds of weather. The driver had a comfortable seat that allowed him to sit in an erect position. He could see out of a sufficiently wide windshield that was protected by an outside visor, and thin windshield pillars offered no blind spots to him in his view of the road. These vehicles were high enough to let the exhaust gas and engine fumes blow away from them. Tire changes and the application of tire chains could be performed in a comparatively easy manner, and the cars had enough ground clearance and enough weight concentrated toward the rear to allow them to traverse bad and slippery roads. The occupants of the vehicles could enter and leave them with ease, and the bodies had ample room for the comfort and good vision of the passengers.

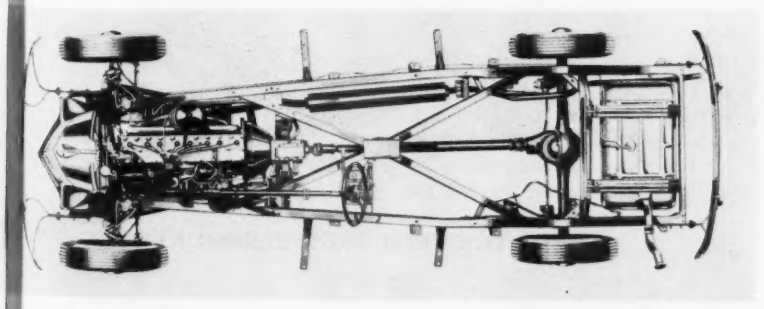
About eight years ago, style became a factor in automobile merchandising, and while mechanical and manufacturing improvements continued, style was considered of the greatest importance. By 1936, style had dominated the mechanical design of an automobile to the extent that many of the mechanical improvements that had been made in cars had been forced to suffer for the sake of better esthetic design. The driver was handicapped by blind spots, limited vision, poor seating, and poor ventilation, and the passengers found it difficult to enter and leave the vehicles. To improve the style, even rain gutters were removed from many cars to the discomfort of the passengers on rainy days. While the driver was being handicapped by style, the power, smoothness, and speed of the vehicles were developed to an astonishing degree and were the cause of many accidents. Style decreed that a car must be low, must look fast, and must be "a big package for the money." Also, by building the cars lower, and by a lavish use of sheet metal to "streamline" them, exhaust gas and engine fumes were trapped under the vehicles, and drawn into the bodies when the cars were in motion. In moving the engines forward in the frames, weight was transferred from the rear end to the detriment of road adhesion of the rear wheels on slippery roads.

In some of the 1938 cars there was evidence that serious thought was being given to safety, and in 1939, as the automobile starts its fifth decade, there is good reason to believe that style in the future will be influenced by safety considerations, comfort, and usefulness. The styling of the 1939 cars is distinctive, and from now on we can expect cars to be dated. The Zephyr, the Cadillac 60 Special, and the Graham introduced styles in 1938 that have been widely copied in this year's cars. The inverted canoe bow with cat walk cooling has met with public approval. How the grilles on the cat walk cooling will function under icing conditions remains to be seen. Cat walk cooling is responsible for some of the fancy bumpers now used, and these bumpers may do great damage in case of collision with pedestrians. As the bodies become lower and wider, the running boards are either eliminated or made optional. In some cars without running boards the lower parts of the doors are flared out to cover the sills. This keeps the sills clean, but in minor traffic collisions the doors may suffer. Alligator hoods are now accepted, and while they make the engine less accessible, it is of no great concern to the driving public, as most repairing and servicing is now performed by service and filling stations.

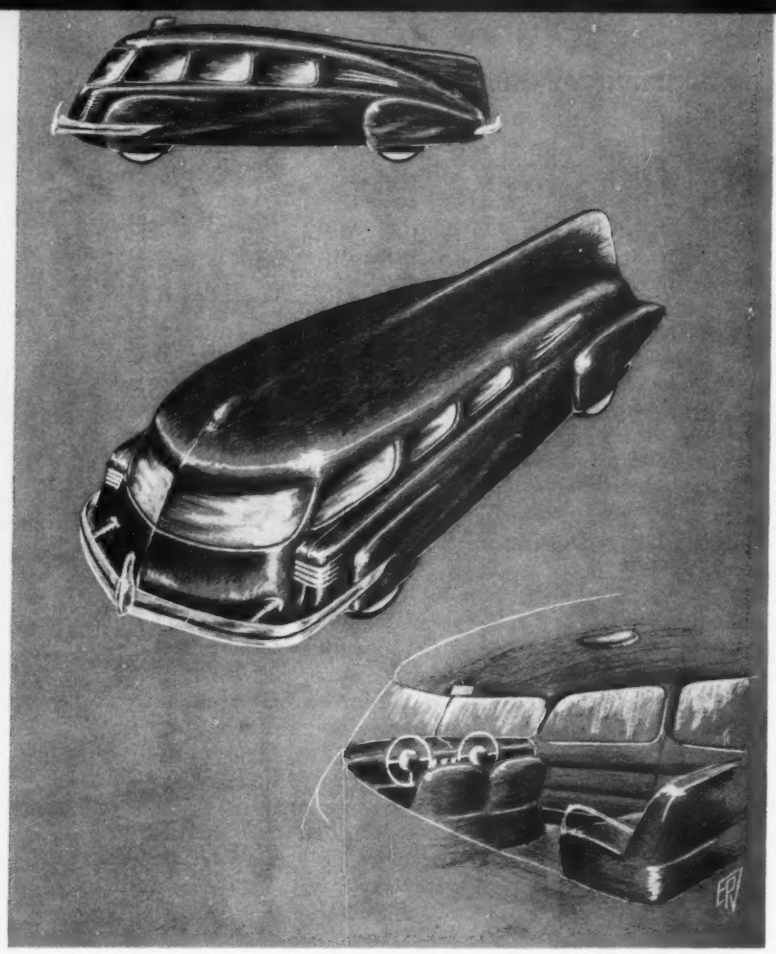
There are two types of body design this year. In one the windows and roof are placed on the body as a superstructure, giving the so-called phaeton effect. The







Photographs courtesy Packard



THE FUTURE AUTOMOBILE

The above design shows the American automobile as it may appear in 1945. The engine and baggage compartment will be in the rear, thus giving far more space in the main body of the car. The body is broadened out as far as the running board of the present car extends. This extra space within makes possible the advantages of movable furniture and seating arrangements for eight people. The broad angle periscope situated in the roof of the car provides rear vision. The dual controls will ease the strain on the drivers, for they can change as often as they wish without stopping the car.

other has a roof which sweeps down in an unbroken line to cover the trunk compartment. In the latter bodies, the rear windows are at such a flat angle that snow and mud can quickly cover them, and outside rear view mirrors are a necessity if the cars are to be operated safely in bad weather. Mud guards are more massive than ever, and the trend is toward placing the headlights in the front mud guards. How well these lights will stay in proper focus after the mud guards are bumped in traffic, or when the mud guards have collected heavy ice loads is a question. Many rear mud guards make tire changes difficult, and the application of tire chains is a real problem. Installing locks on both front doors, and placing the registration plate in the center of the trunk compartment panel are improvements that meet with no sales resistance.

The bodies on the 1939 cars are better insulated against sound and vibrations. Plastics are being widely used for body hardware, and concealed hinges have been employed to reduce wind noises and to improve appearance.

The popularity of sunshine roofs in England has induced some American manufacturers to offer this innovation. The enthusiasm accorded it by the motoring public will determine the probability of its continuance in American cars. The narrower pillars and increased window areas, of this year's models are giving the drivers and passengers better vision, and this improvement is being welcomed with such enthusiastic approval that it should encourage the manufacturers to continue in perfecting it. While the fair weather vision has been improved, the stormy weather vision remains restricted, because of the limited areas that can be cleaned by windshield wipers on the stylish Vee windshields, which are now used in most of this year's automobiles. The slanting windshields become dirty more quickly than the older and more nearly vertical ones, and are also much more difficult to defrost. In Vee windshields, the driver has to refocus his eyes when his line of vision passes from one pane to the other, resulting in fatigue. In rainy weather when driving through city lights, the Vee windshield has blind spots and reflections that are confusing and dangerous to the driver. With the coming of wider bodies, and the demand for better vision, it is possible that slightly inclined, single paned windshields with narrow pillars may return. Several years ago, many English cars used Vee windshields, but in the 1939 British cars, the wide vertical windshield with narrow pillars has returned to general use.

Most cars have the gear shift lever placed under the steering wheel, and while it is more awkward to operate than the former "wobble stick," it does permit three people to ride more comfortably in the front seat. Gear shifts located under the steering wheel will probably be used until the long awaited automatic transmission becomes a commercial reality. Instrument boards have so much bright work that their reflections on the inside of the sloping windshields are trying to the eyes. Many new steering wheels with light colored rims and highly polished spokes are also a minor source of eye fatigue.

For several years automobiles have been so smooth and quiet in their operation, that the drivers have had no real appreciation of their speed. This year the Chrysler built cars have incorporated colored lights in their speedometers to warn the driver more effectively of his speed, and thereby reduce accidents caused by fast driving. Other cars have changed the size and positions of their speedometers to make them easier to read. Automatic radio tuning has been adapted to automobile receiving sets, and its simplicity of operation is a safety feature which allows the driver to concentrate more of his attention on the operation of the car.

The use of frothed latex cushions in a few cars this year will probably meet with such public acclaim that they will be in general use before long. These cushions give the motorists much greater riding comfort.

One of the notable developments of last year was

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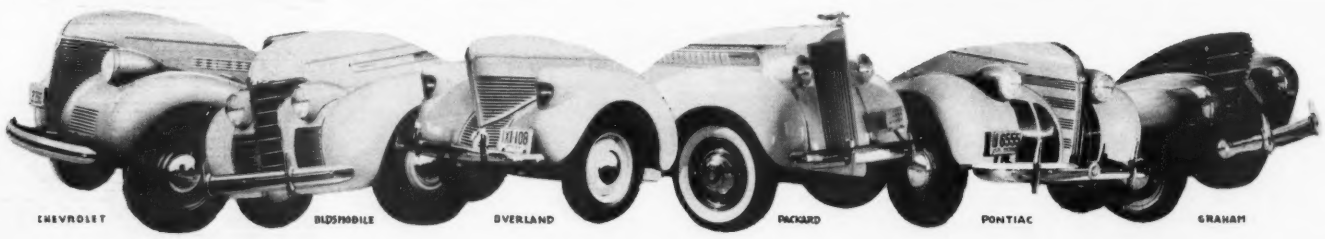
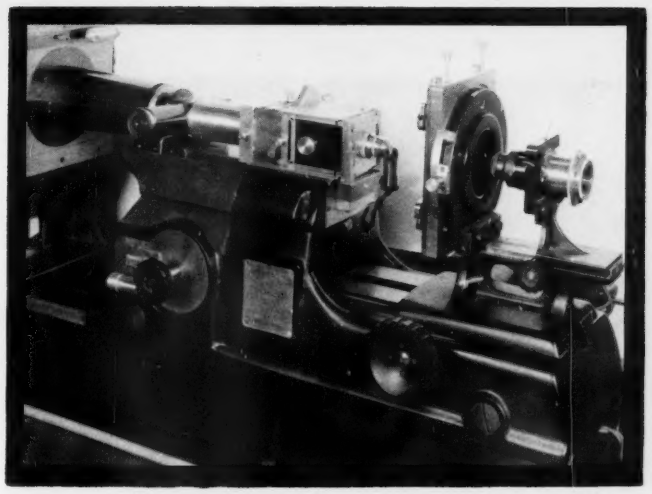
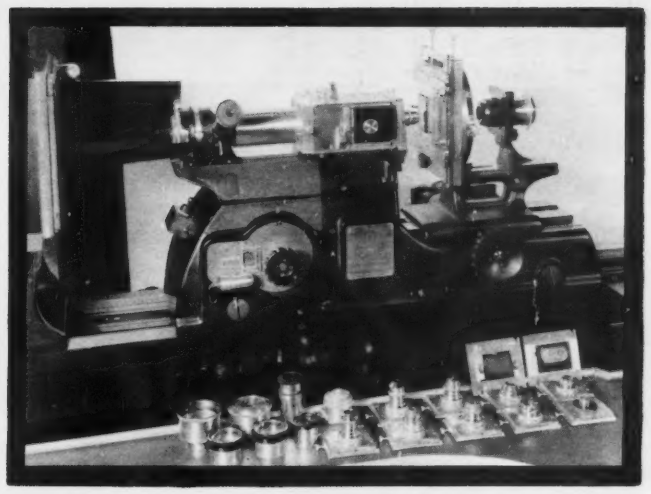






Shown above is the microscope section of the most recently developed photomicrographic camera

Photography and Metallurgy

ROBERT S. WILLIAMS

THE beginning of photography came when the discovery of the effect of light on certain chemicals was made by a German chemist, Schultze, in 1727, when he noticed that chalk dipped in a salt solution and then treated with silver nitrate darkened on exposure to light. As a next step he covered a slab of chalk with a sheet of paper with stencilled letters and was able to print by exposure to the sun. It was not until 1802, however, that an attempt was made to reproduce objects. At that time Wedgwood impregnated paper with silver bromide and by exposing it to sunlight under a painting made on glass he was able to produce what is said to have been a satisfactory reproduction of the painting. No method of making the print permanent was known, so these photographs could only be viewed in a darkened room and none has been preserved. Less than a hundred years ago Daguerre and Niepce discovered a method of "fixing" the image, and modern photography has been the result.

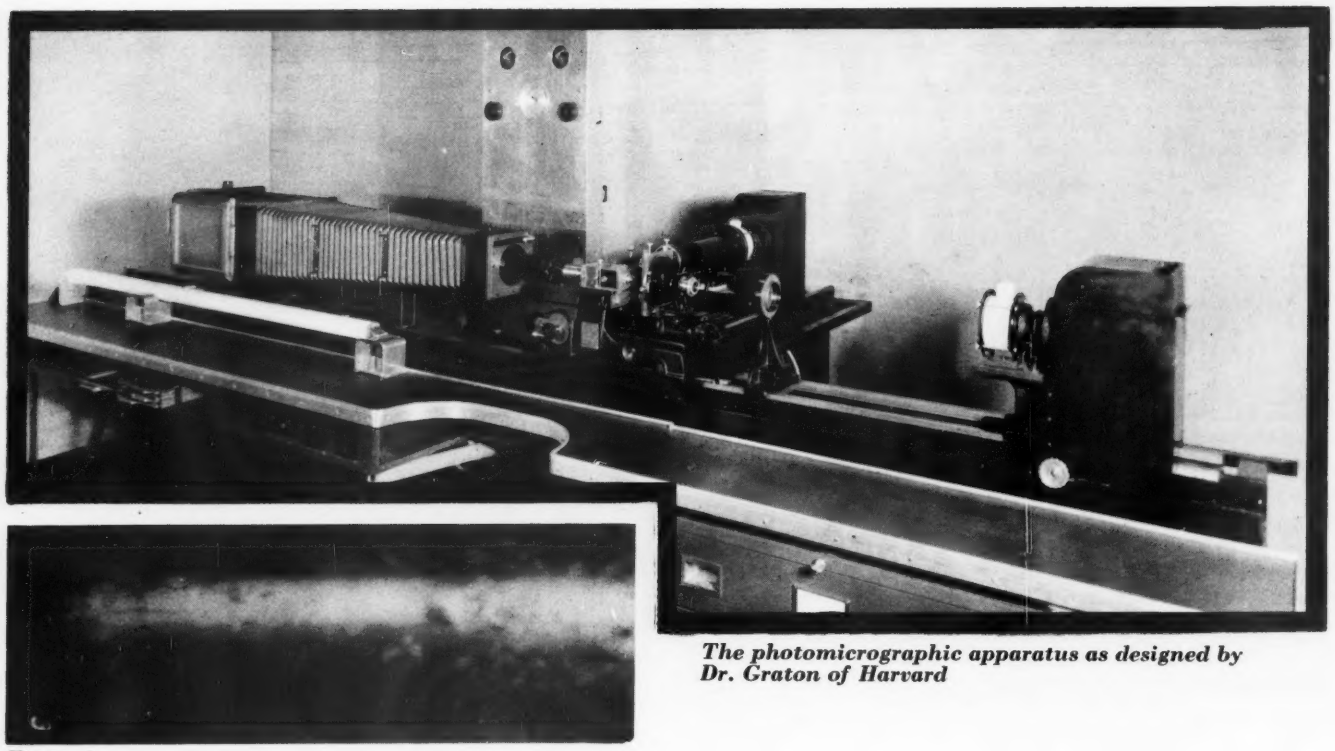
In the early history of metallurgy the experimenters were interested in the gross structure of metals and alloys and did not realize the significance of the internal or microstructure of the metal. It is probable that the surfaces of polished metals were microscopically examined in the early days of the microscope, but the first authentic record of the use of the microscope for metallurgical purposes is in a paper by Sorby published in 1864 with the title "On a New Method of Illustrating the Structure of Various Kinds of Steel by Nature Printing," followed shortly by a paper "On Microscopical Photographs of Various Kinds of Iron and Steel" published in the same year. From this date papers dealing with the uses of the microscope were published at long intervals by Sorby, Martens, Wedding, and Roberts-Austen. Much of this early work was illustrated by sketches or at times by drawings made in the "camera obscura."

The first attempts at the photographic reproduction of a polished metal surface were made by attaching a camera bellows to an ordinary microscope. Since the polishing of a metal surface was difficult with the equipment available in the early days and because the photograph had to be taken by the light reflected from the polished surface, the first metallurgical photographs were taken at very low magnifications. Sorby's original picture was at nine diameters magnification. With improved techniques of polishing and illumination the magnification was increased gradually up to one hundred diameters, but it was not until 1890 that Osmond in France so greatly improved both the polishing and photographic methods that magnification of three hundred to five hundred diameters became possible. While Osmond was by no means the first to use photography for metallurgical purposes, it is generally believed that his papers in the period from 1889 to 1895 furnished the background for the new science of microscopic metallurgy now known as Metallography. Osmond's early photomicrographs taken almost fifty years ago compare most favorably with those of the present day.

The inconvenience of the early arrangement of the camera vertically attached to the microscope soon led to the invention of the horizontal type camera, in which by a suitable mirror system the magnified image of the polished and etched metal is projected in a horizontal rather than in a vertical plane, and the operation has been much simplified. Several types of metallographic cameras (metalloscopes, metallographs) are now available, differing not at all in the basic principle but varying widely in optical and mechanical equipment. These differences are reflected in a price range of from a few hundred dollars for a shop instrument to twenty thousand dollars or more for a specially designed research camera.

Dr. F. F. Lucas of the Bell Telephone Laboratories is recognized as the leader in the field of high magnification photomicrography. Using ultraviolet light as the source of illumination, Dr. Lucas has made a number of photomicrographs that for definition and detail are unsurpassed. Using a camera designed by him (Fig. 1) and with special lenses, photographs have been taken at magnifications of seven thousand diameters, and it seems certain that with optical and mechanical improvements still greater

Figure 1



The photomicrographic apparatus as designed by Dr. Graton of Harvard

Figure 2

magnifications will be possible. The increase in magnification from the nine diameters of Sorby to the seven thousand diameters of Lucas has opened to the metallurgist an entirely new field of investigation.

The most recent photomicrographic camera is described in the *Journal of the Optical Society of America* in November, 1937. This instrument was designed by Dr. L. C. Graton of Harvard with the co-operation of many workers in the field. While there are some changes in the optical set-up, its outstanding characteristic is in the use of a focussing device many times more precise than anything that has been used. The camera is intended for petrographic work so that little information is available concerning its use for metallurgical photography. It seems probable, however, that the magnifications will be considerably greater than any now available.

It is hardly necessary to add that the great increase in power of these new instruments would not have been possible without a corresponding improvement in the production of fine-grained and ultra-sensitive plates and films.

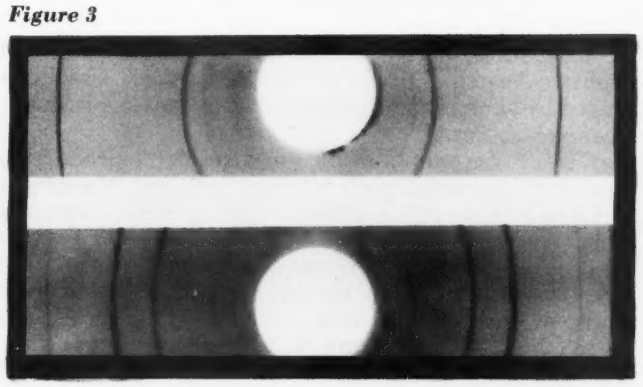
Another vitally important application of photography in metallurgy has been the use of the X-ray. This had its beginnings shortly after the discovery of the X-ray. The first use of the new tool for testing purposes is generally credited to Dr. Albert Sauveur (M. I. T. '89) in 1896. Sauveur was not only the first to recognize the possibilities of X-ray examination of metals but is associated with the pioneer group of metallurgists whose work showed the tremendous importance of photography in metallurgy. X-ray photographs are of two general sorts, the radiograph showing gross internal defects in metals, as for example blow holes, slag inclusions, and the like (Fig. 2), and second X-ray diffraction photographs (Fig. 3) by means of which the arrangement of the atoms in the metal may be determined. The diffraction method has contributed immeasurably to the present knowledge of the structure of alloys and of internal changes so slight that they can be detected in no other way, while the radiograph has made possible the non-destructive testing of finished parts. Literally thousands of radiographs were taken during the fabrication of the large steel pipes used in connection with the Boulder Dam.

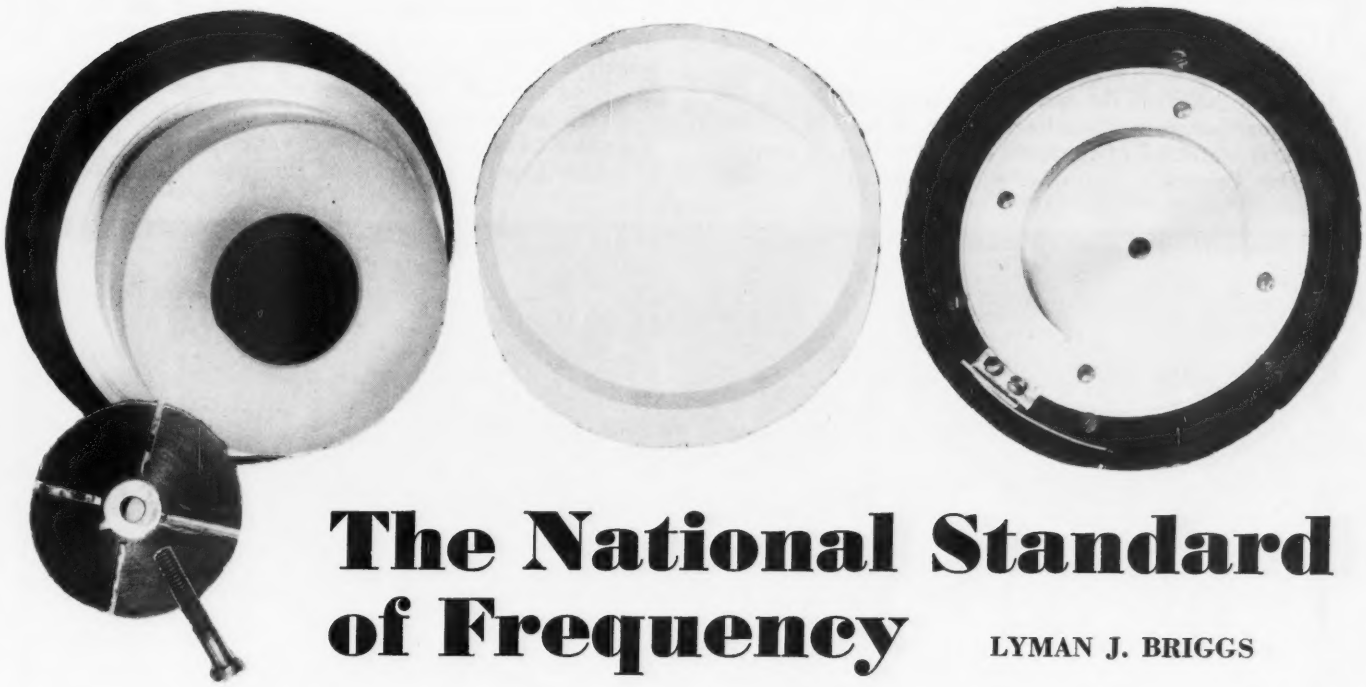
The thickness of steel that can be photographed by the X-ray is determined by the voltage applied to the tube used, and at the present has an upper limit of about five inches. Much greater penetration is possible if the gamma-ray emitted by radium or radium emanation is used as the light source. With this device photographs have been taken through ten inches of steel.

Since neither the X-ray nor the gamma-ray is visible it is indeed fortunate that both rays darken the photographic emulsion. In the special field of metallurgy, then, photography is not merely of value as a method for obtaining a permanent record, but is an indispensable tool without which the present knowledge of the atomic structure of metals and alloys would not have been possible. The photographic film not only shows the presence of the X-ray but also measures its intensity. The more intense the ray, the more dense (blacker) will be the spot or line produced by it. The blackness of the line formed under controlled conditions can be measured by a densitometer, and as a result the photographic film may be used in many cases to

(*Continued on page 203*)

Figure 3





The National Standard of Frequency

LYMAN J. BRIGGS

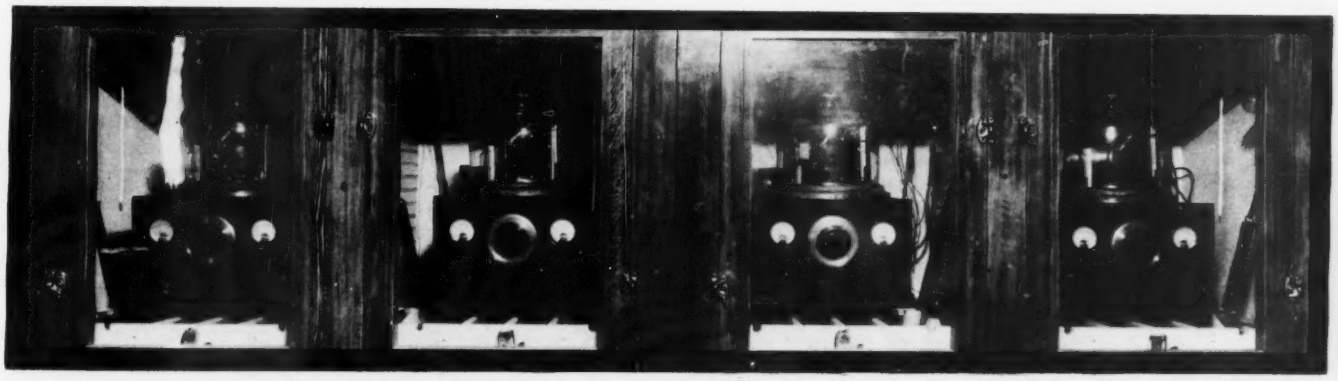
THE precise control of frequency is becoming more and more important. Our present broadcasting industry, with many stations "on the air" at the same time, is possible only because each of these stations holds closely to its assigned frequency in sending out its program. These frequencies, which are assigned by the Government, are selected so as to eliminate interference insofar as possible.

A prerequisite to the precise control of frequency is a frequency standard of great precision. Against this standard frequency, all other radio frequencies are checked either directly or indirectly. The official custodian of this standard in the United States is the National Bureau of Standards in Washington.

The construction and maintenance of any kind of a precision standard is never an easy matter, and in the case of a frequency standard the situation is particularly complex. Inasmuch as frequency is dimensionally a reciprocal of time, it is fleeting and must be created anew whenever it is to be used. For this reason it is particularly fortunate that standard frequencies can readily be broadcast, thus making the "standard" available to all who need it.

Fortunately, we have in the quartz oscillator a frequency standard of extremely high accuracy and one that can be arranged as part of the circuit of a radio transmitting set which in turn can send out standard frequency signals. The phenomenon of *piezo electricity* has been known for a long time, but its application to radio frequency standards dates back only about thirteen years. Certain crystals, as for instance crystalline quartz, undergo slight changes in form when an electrical voltage is applied to them, and conversely the crystals produce a slight voltage when compressed or expanded. A small piece of quartz crystal, cut in the proper shape, has a high natural frequency of the same order as the frequency of the currents used in radio communication. Its natural period of vibration remains constant provided the temperature is not allowed to vary. Although quartz has a low coefficient of thermal expansion, its dimensions, and consequently its natural period of vibration, do change with temperature. In association with an electron tube, the quartz crystal can be made to act as an oscillator or a generator of an electrical voltage, the frequency of which is that of the mechanical vibration of the piece of quartz. As the

Those parts scattered above form the heart of a piezo oscillator. The piece of pyrex tubing serves as a distance piece between the aluminum end pieces which constitute the electrodes. Below are four complete oscillators which with three others dictate the National Standard of Radio Frequency.



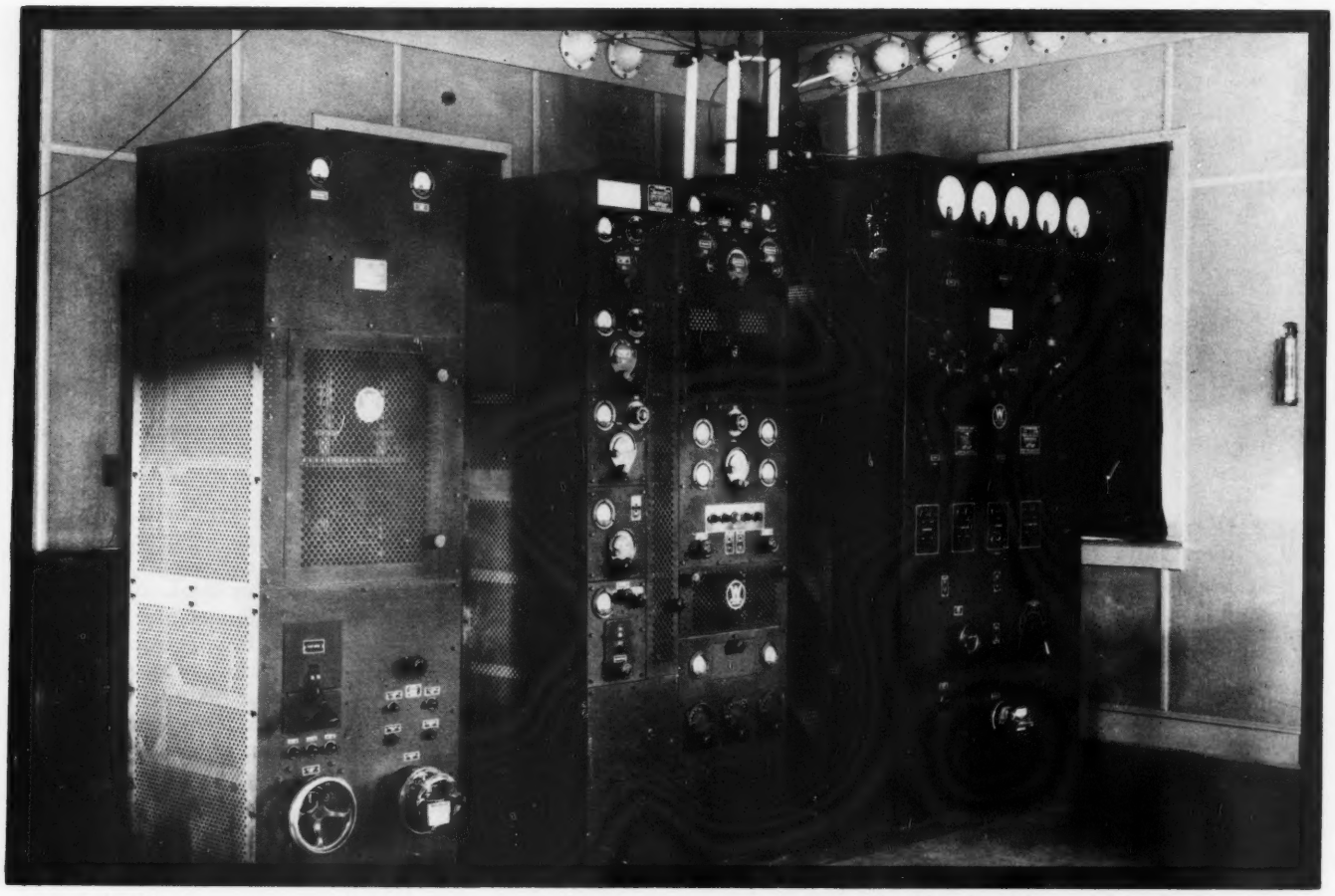
frequency thus produced is accompanied by numerous harmonics, the crystal is a standard giving several frequencies. A quartz oscillator and accompanying apparatus can be used to send out standard frequency signals, or can be used as the control equipment for a radio broadcasting station.

At the National Bureau of Standards in Washington there are seven quartz oscillators, constituting the national standard of frequency for the United States. At the Bureau's transmitting station at Beltsville, Maryland, are three more oscillators which may be considered in the nature of secondary, or working standards which are used to control the frequencies of the emissions sent out by the Bureau for use all over the country. The natural frequencies of these oscillators are 100 kilocycles and 200 kilocycles. Four of the oscillators at Washington were supplied by the Bell Telephone Laboratories, while three were designed and constructed at the Bureau. All are carefully protected against external vibration, and temperature and pressure changes, and are constantly checked among themselves. By means of a submultiple generator, one of the oscillators is used to drive a synchronous motor-clock indicating mean solar time. This can be checked against the clocks of the Naval Observatory, which constitute the primary standard of time for the United States and to which the frequency standard is referred.

The standard frequency emissions from Beltsville are controlled by one of the group of three oscillators at the transmitting station, which are in turn checked against the mean frequency of the group of oscillators in the Bureau's laboratory at Washington. Careful records kept of the Bureau's standard frequency emissions show that they do not deviate from the assigned frequencies by more than one part in five million, and generally are accurate to better than one part in ten million.

The standard frequency emissions of the Bureau are of value for many purposes, the most important of which may be listed as follows:

First, the radio frequencies may be used for calibrating standard oscillators in simple cases where the frequencies have such numerical values as to be readily checked directly in terms of the emissions. The frequencies of these emissions are 5,000, 10,000, and 20,000 kilocycles.



All standard frequency transmissions are sent out by this equipment at Beltsville, Maryland

Second, by using certain auxiliary apparatus, the radio frequencies are suitable for checking broadcasting frequencies.

Third, at certain times, a standard audio frequency is furnished as a modulation frequency which may be used for checking a local frequency to control a source of audio or other frequency, and for producing a standard of time rate.

Fourth, standard time intervals, or "second pulses," are furnished. These are very useful in physical measurements, in geodetic, seismological and similar work, and in the rapid checking of pendulum and chronometer rates, or wherever short time intervals of great accuracy are needed. It should be remembered that they are interval standards, and do not give solar time which is supplied by the Navy time signals.

Fifth, the Bureau broadcasts the American standard of musical pitch, 440 cycles per second, a service available to musicians, musical instrument makers, piano tuners, and others.

Considering these services in order, the standard

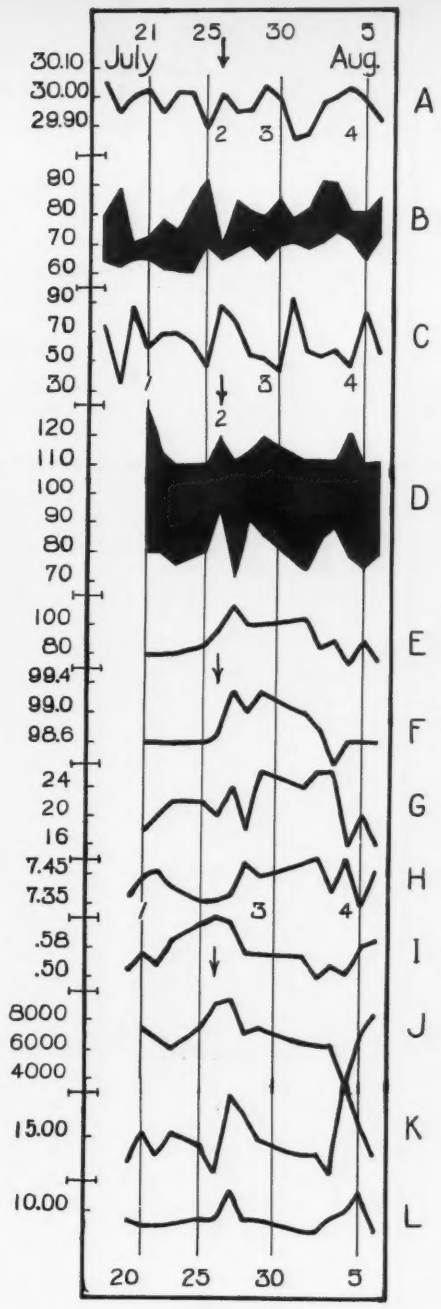
(*Continued on page 206*)

The Common Cold

ITS METEOROLOGICAL ASPECTS

FREDERICK SARGENT

ONE of the most baffling problems confronting medical research workers today is the origin and the development of the common cold and related infections of the upper respiratory tract. The common cold is defined as an acute inflammation of the mucous membranes of the respiratory tract, but investigators are not agreed on the exact origin of this inflammation. The present consensus is that the common cold is caused by the filterable virus, a complicated protein molecule with an hypothetical existence; that is, in some cases it has been demonstrated experimentally that the cold is caused by this filterable virus, but in many other cases the cause of the cold is not quite so simple as just the result of a virus invasion. Other investigators feel that the origin might be bacterial in nature or due to one of the cocci; e.g., pneumococci, staphlococci, or streptococci. Assuming then, in the face of these facts, that the common cold is probably caused by some agent, whether bacterial or chemical, which irritates, inflames, and often infects the respiratory mucosa, what factor or factors predispose to respiratory infections?



BIOMETEOROGRAM

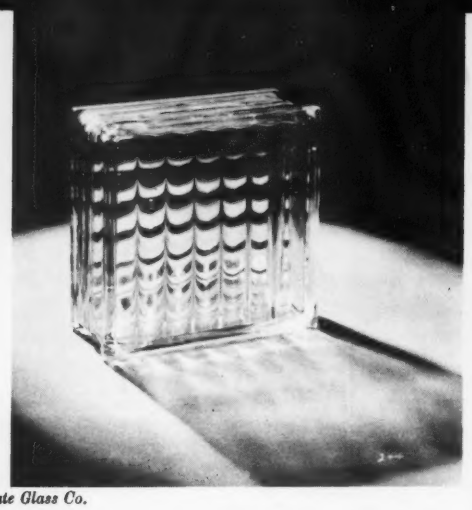
To answer that question, we are faced at once by a multitude of factors, all of which bear some significant part in determining the time when the cold will be initiated. In fact, there is probably an "accordance" (as Linke states it) of factors influencing the human body so as to predispose it to invasion by harmful agents. In this paper we shall be concerned with the meteorological influence on the human organism, for it is indeed one of the most obscure in the minds of medical researchers. The cumulative effect of fatigue caused by overwork, extreme exercise, and improper sleep are obvious. The effect of diet is also an important factor, but its inclusion is beyond the scope of this paper.

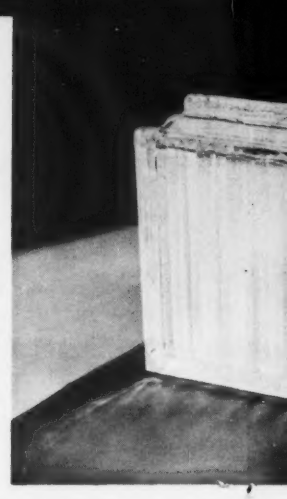
The human organism, although we are not always aware of the fact, is continually reflecting the changes that occur within its environment. It reflects each storm that passes over the individual, but the biological reaction is clinically manifest only when the individual is in a susceptible condition, or the individual is especially sensitive to meteorological changes, as some persons are. For example, some persons have no colds during the course of an entire year, while there are those who have as many as fifteen colds in nine months. Possibly there is some physiological difference between these individuals, but the point is that there are some very meteorologically sensitive persons. Again the common cold often accompanies many operations, and it generally precedes pneumonia or bronchitis. We can see, then, that the common cold is one definite clinical manifestation of the biological fluctuations that take place in all individuals.

To investigate quantitatively this biological phenomenon requires the use of several techniques. A considerable amount of biochemical data must be obtained covering a sufficiently long period of time and a sufficiently large and homogeneous group. Daily observation on the patients is the preferable method, for the weather is so variable. The biochemical data for each patient must then be compared with the daily meteorological records obtained from the United States Weather Bureau office for any correlation that may exist. From a study of several individual cases the generalizations may be made. Any other method will lead to inaccurate results. The individual cases should be classified into several groups of different types of individuals, and the reactions of the different types determined therefrom. Also, if there is any indication that the onset time or the reactivity of the patients is seasonally determined, the data should be grouped according to seasons and investigated for further generalizations. The important point to bear in mind at all times is never to generalize from averages obtained from a large heterogeneous group, but to generalize only from data obtained by a study of a convenient homogeneous group.

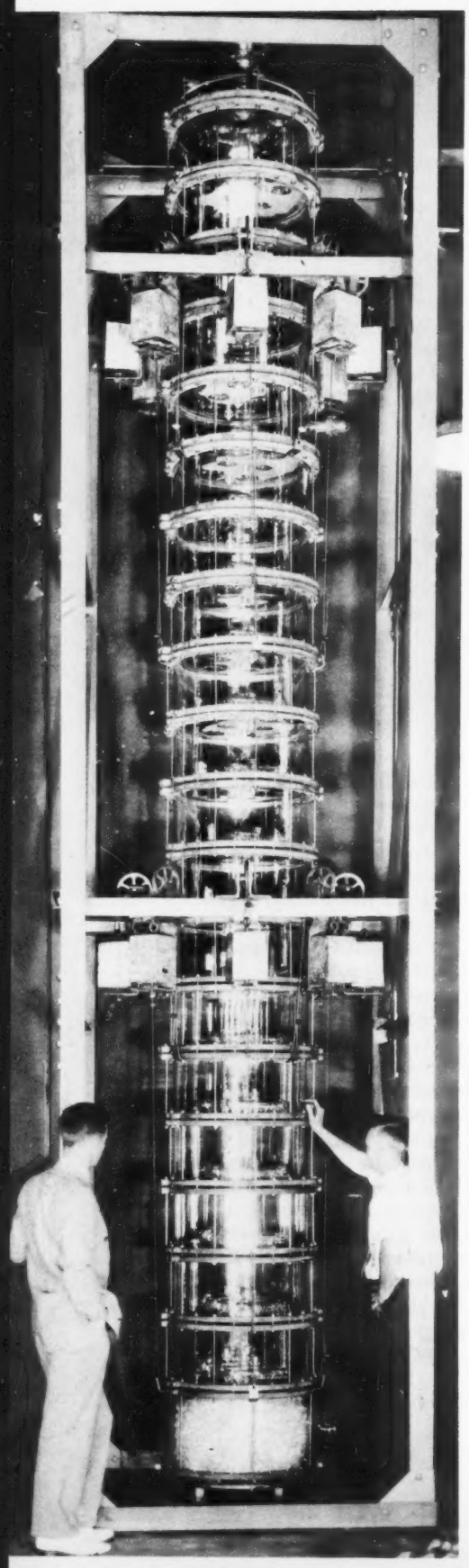
The accompanying biometeorogram illustrates the results of a biochemical investigation conducted by the author from July 20 to August 6, 1938 at the University of Illinois College of Medicine in Chicago. A sample of the author's blood was drawn daily, except Sunday, at 11 a.m. for chemical analysis. In addition to the drawing of 20 c.c. of blood, a record of the blood pressure, oral temperature, pulse rate, and respiratory rate were made at this time. The author lived a normal life during the period, and he kept a daily record of his moods, general health, and any abnormal occurrences. During the period of observation a cold which developed into bronchitis was recorded. The curves D through L summarize this biochemical data. The blood pressure is indicated by Curve D, the upper

(*Continued on page 204*)





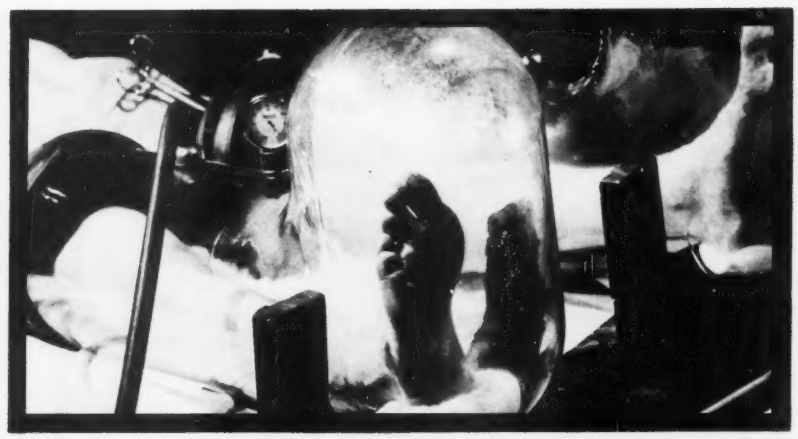
Photographs courtesy Pittsburgh Plate Glass Co.



Corning

Fractionating tower

GLASS



Corning

FROM the earliest records of civilization we read of glass and its manufacture by the ancients. The opening of the present century saw the uses of this material, over four thousand years old, approximately as undeveloped as when the ancients first had used it. And we were still accustomed to think of it in terms of windows, bottles and mirrors. Glass has always had a practical purpose, but until the last few years that practical purpose had hardly been widened.

Today we find glass of high purity in a variety of uses important to all branches of modern science. The medical profession has long been using special glasses developed for filtering out or transmitting specific bands of the spectrum all the way from X-rays through the ultra-violet and visible into the infra-red. These special glasses have been used by physicians and dentists for protection against X-rays and for the effective transmission of these rays. Moreover, other glasses have been manufactured to transmit in the ultra-violet and therapeutic wave lengths only. Still another transmits ultra-violet but absorbs all visible light, and is used with fluorescent materials to produce weird stage effects. A recent and unique innovation is a glass which will provide its user with any of three varieties of sunlight he may desire — direct sun, northern sky, or overcast sky — when light from an incandescent lamp passes through it.

It is interesting to note that all of these glasses have been developed only within the last few decades. Pioneers in this field of expansion have been the Corning Glass research men, who have given us such things as flexible, almost shatterproof glass (which when it does shatter, breaks into hundreds of small harmless pieces), the Pyrex glassware which we use in the laboratory, and the newly developed glass fiber which is coming into extensive use as a heat insulator. This use of glass for heat insulation is by no means untried. "Glass wool" h
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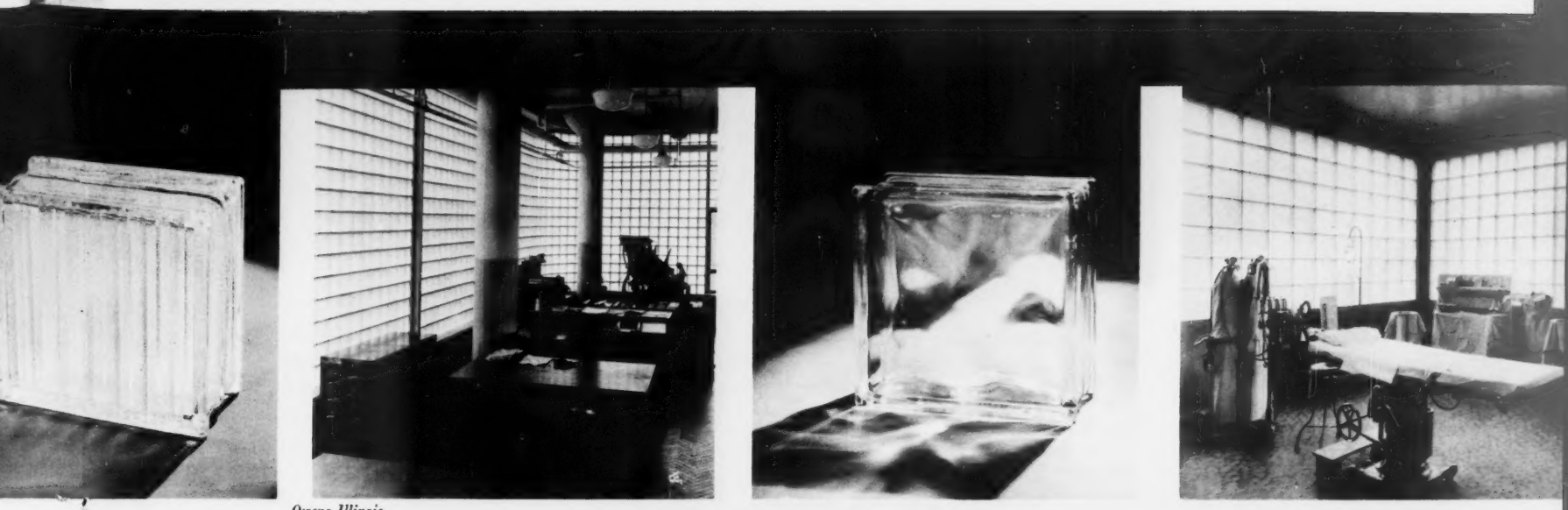


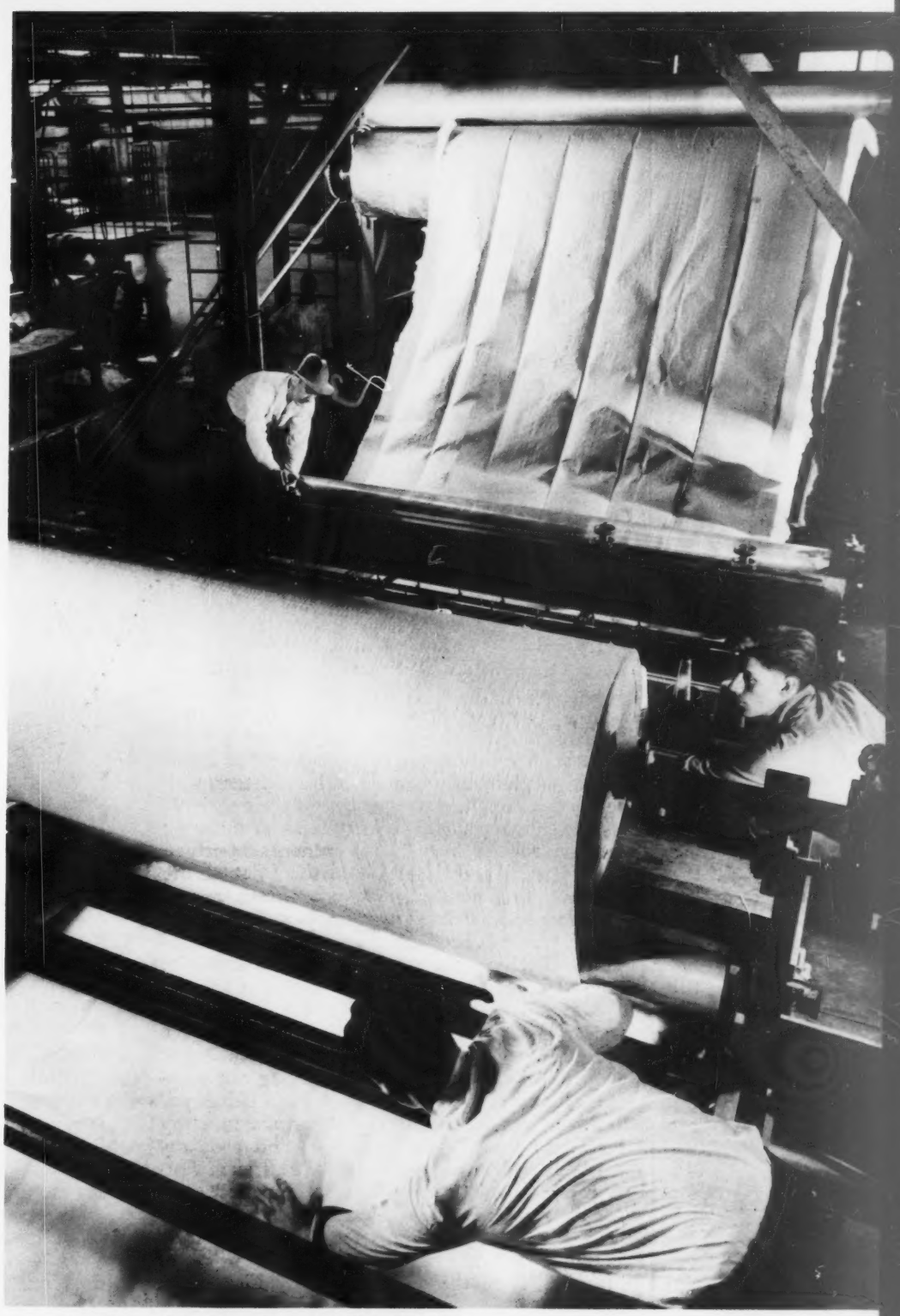
Owens-Illinois

S

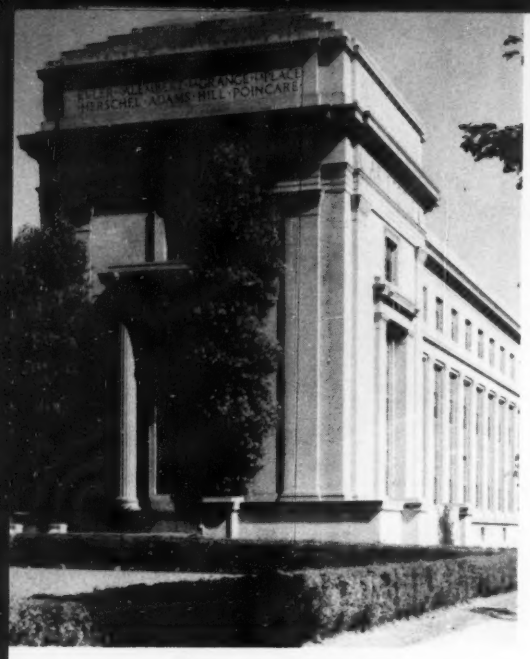
lass wool" has been used in foreign countries for over as an insulating material, with a record of uniformly erformance. In this country it is now coming widely h for domestic and agricultural purposes. As manufac-, it comes as a well-felted mass, free from the objec-urities which are found in many insulating materials ng all the chemical stability characteristics of glass. y quality of this wool is its resistance to settling even everest conditions of vibration. This characteristic is ost insulating materials do not possess, and is due to esiliency. Thus it is being widely used in ships and , where continued vibration prevents the use of other aterials. Moreover it is light in weight and easily s an excellent thermal coefficient of insulation and is l by acids, vermin or weather, and is capable of with-nperatures up to 1,000° F.

ool is also being manufactured for floricultural pur-e it should soon find a wide demand as an insulating his "mulching wool," unlike organic materials such as w, excelsior and the like, which are used to protect nts from changes in atmospheric conditions, is com-in-proof and is not subject to deterioration with time. riculturalist is provided with a material which he can ar to year with proper handling — and more impor-ial which is far superior in insulating properties. Tests niversity have showed this material to be from 20 to more efficient than the usual mulching agents.

w glass bricks, or blocks, which have been on the everal years are at last coming into their own, thanks ve architects who have seen their advantages both nt of view of efficiency as well as beauty. Walls of a novelty several years ago, are now in general use ces where a large light area is desired without in any ng the strength or permanency of the building. More-nslucent quality possessed by these glass bricks makes larly desirable for lighting the home and department es where privacy is desired along with plenty of light unsightly view detracts from the general harmony of heir use in factories is particularly advantageous where ensation on window glass is a problem. Tests have noisture will not condense on the warm side of one of ocks even with a relative humidity of 65 per cent and in temperature of from 0° F. to 70° F. This is espe-ant where high humidity results from certain manu-ocesses. In addition, these glass blocks offer another ntage. Owing to their hollow structure, which con-partial vacuum, these glass blocks permit less than eat loss that takes place through an equal area of s. They also provide excellent insulation against sound.



Fibrous glass insulating blankets, Corning Glass Works



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EDITORIALS

COLLEGE MEN?

Student pranks, often approaching a degree of vandalism, seem to characterize undergraduate life in American universities more so than at foreign institutions. Although one of the mottoes of M. I. T. is that "Tech is a place for men to work and not for boys to play," there are exceptions to every rule. The Institute's record is occasionally blemished by funsters, who do not seem to realize the consequences of their actions.

During the summer in which the present Technology Store was constructed, a group of students inscribed the popular cheer, "Tech is Hell" on the front of the building above the window displays. More recent pranks include periodic dormitory fights and snowball battles, which result in broken windows and irate Cambridge police. Perhaps the most destructive antics of this term occurred the week before Field Day, when the freshman numerals were painted on the buildings and the flagpole ropes were destroyed in order to raise a '42 banner.

Although these capers provide interesting conversation for an alumni reunion when "the good old days" are revived, the immediate effects are harmful in many ways. First and foremost are personal and property damages which appear as the results of all such fun-making. Damaged property must be repaired, and when the guilty remain in the background, those who had no part in the destruction must be taxed directly or indirectly. Well over one hundred dollars' worth of damage resulted from the disturbances on Field Day.

Another damaging effect is the false impression which outsiders may obtain of the true Institute life. The constant risk of lowering the school's reputation probably never enters the prankster's head. He forgets that any unit of education is judged primarily by the undergraduates and their activities. Then, too, vandalism fosters a relaxation in self-discipline and accomplishes a lowering of moral standards, which is more than injurious to the student's character. These are but a few of the results caused by "letting loose" at the expense of someone else.

It is true that constant study and mental activity create an emotional strain which clamors to be released. This tension may be much more beneficially eased by participation in extra-curricular activities and athletics than by destructive pranks. Any outside interest, such as publication work, which broadens the student's horizon, will serve to ease the strain and at the same time provide recreation which is a vital supplement to actual study.

Both good and bad habits are formed in college. Whereas it is not difficult to break a good habit later, it is almost impossible to correct a bad habit in after life. One thing which engineering, above all other courses, teaches is responsibility upon which human life may some day depend. Therefore, any personal code which a student develops in college that will tend to make him more conscientious and reliable is almost as valuable in his future work as the learning that he has acquired.

THE POWER OF THE PRESS

The past few years have seen a flood of magazines proclaiming inventions and new advances of science in a sensational manner that makes interesting reading matter, but leads to false impressions in the mind of the layman. Scientifically trained men have been able to see through the farce, but nothing has been done to right the wrong that was being done to the people. This condition is slowly being remedied. Just recently the New York Cancer Committee presented the National Association of Science Writers with the Clement Cleveland Medal "for outstanding work in the campaign to combat cancer." The Association was highly praised for giving only strictly authentic reports of the advances made in the battle against cancer. This organization of writers is very small — probably because of the high standards of membership — and it is greatly outnumbered in its fight against misleading ballyhoo of scientific discoveries. Probably the reason for the generally poor scientific reporting is the lack of scientific training for writers.

The growing demand for truth is accompanied by a demand for writers with scientific background. The young engineering student is too much inclined to belittle the importance of being able to write logical and easily understood prose. The fact remains, though, that scientific advances are of little value to civilization unless mankind is able to understand them. Too often in the past great discoveries have fallen into oblivion because the discoverer was unable to record his finding in writing.

Here is a double opportunity for the scientist or engineer. Scientific magazines and journals need competent editors that are grounded in both science and journalism. Inventors often need scientifically trained writers to present their discovery to the world. Logical writing is nothing more than clear thinking, and scientists and engineers are more carefully trained in thinking than other people. The scientific journalist holds in his hands the power to keep relations between science and the layman clear. The definite demand for the scientific journalist makes the position lucrative as well as powerful. Any student with any literary talent at all would do well to give this matter serious consideration.

THE OLD ORDER CHANGES

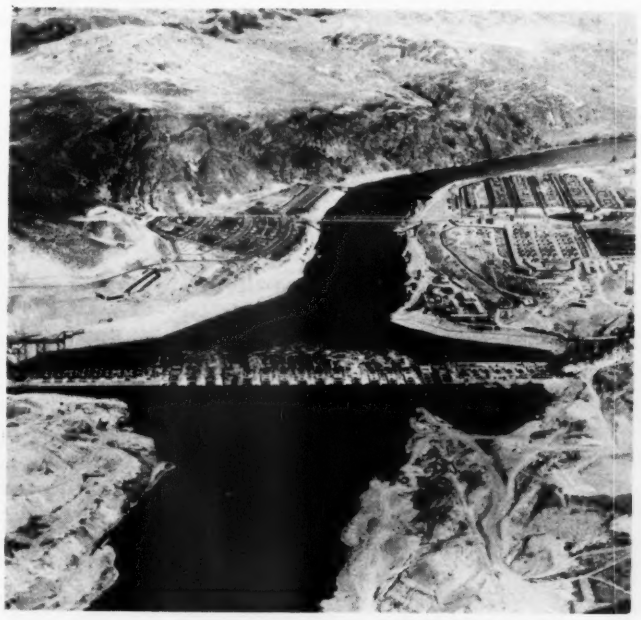
It is with deep regret that the Managing Board of Volume XIX turns over to their successors of Volume XX, the reins which they have held for the past year. In the time which we have been on the staff of the magazine we have seen many opportunities for improvement, and have succeeded in carrying out some of them. The content of the magazine has been broadened with the introduction of articles on the problems of personnel and labor relations. The old policy of getting articles from outsiders, alumni, and members of the faculty has been followed with every effort bent to obtain our material from men who are real authorities in their fields.

We have tried to plan ahead and insure, with the coöperation of the men on the new Board, a continuation of this policy. It has long been our opinion that material of this sort was better received by our readers than were articles prepared by the members of the staff. We were vindicated in this by the returns from the poll conducted last year.

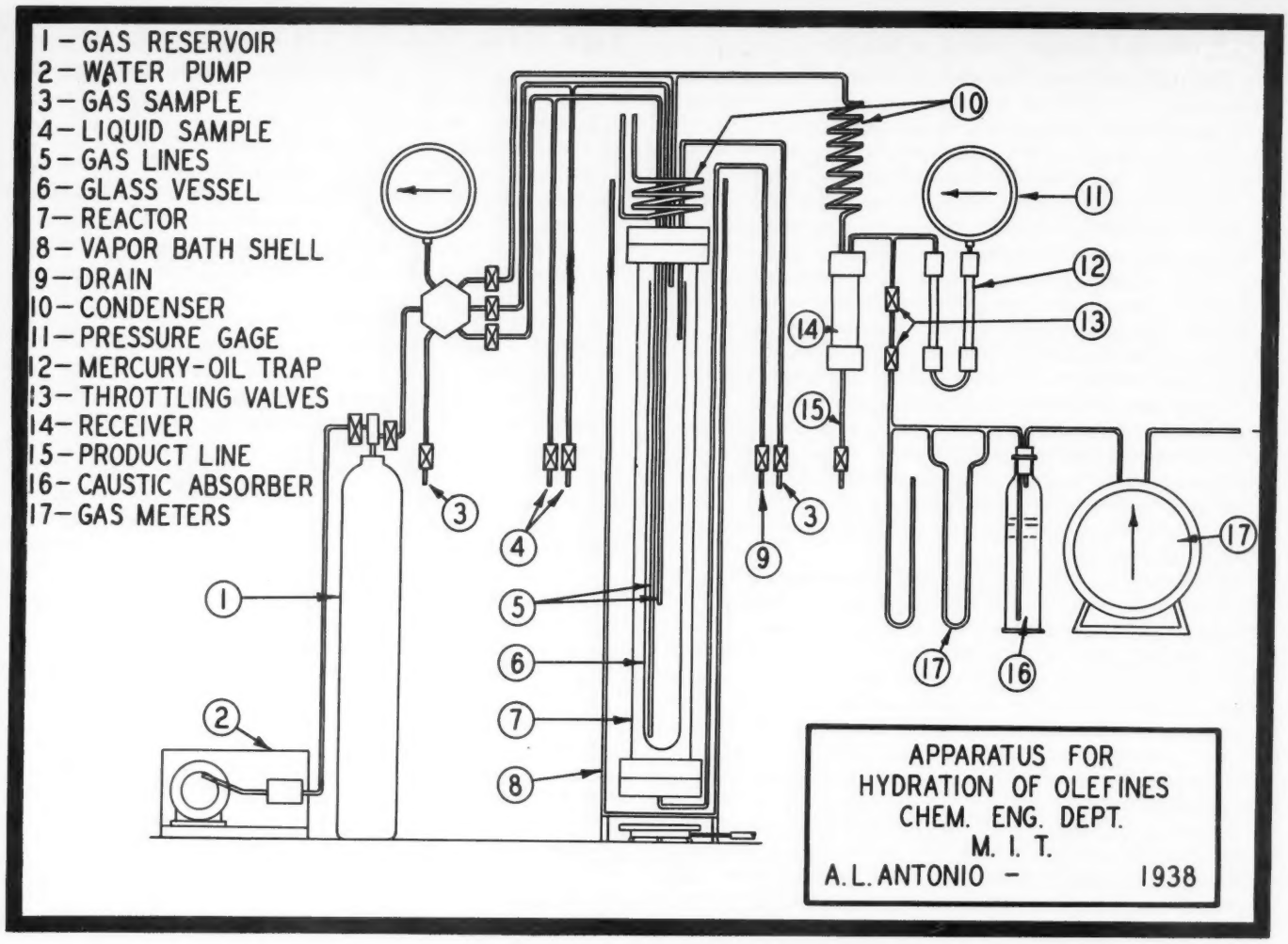
There had long been a feeling in the magazine that an Art Department was needed — to assist the Managing Editor in the layout of the magazine, and to aid in the miscellaneous artwork that is a necessary part of the publicity. When the present Board was named provision was made for an Art Editor, who has been of immeasurable value. His duties have led him into all the phases of the magazine where art has been needed: posters, advertising, and layout.

The new Managing Board will be: R. Dixon Speas, '40, General Manager; Jack H. Schaum, '40, Editor-in-Chief; Samuel P. Card, '40, Business Manager; as the Senior Board. The Junior Board who will assist them is composed of: Eugene E. DuP. Crawford, '41, Art Editor; Walter E. Morton, '41, Managing Editor; Donald D. Scarff, '41, and John W. Mullen, '41, Associate Editors; Harry J. Heimer, '41, Advertising Manager; Warren J. Meyers, '41, Circulation Manager; John Van Riper, '41, Publicity Manager; Lloyd B. Wilson, '41, Treasurer; Arnold S. Mengel, '41, Personnel Manager; Laurence P. Russe, '41, Associate Treasurer; and John B. Murdock, '41, Associate Advertising Manager.

Grand Coulee Dam



All-American Canal *Photographs courtesy Bureau of Reclamation*



Technology

HYDRATION OF OLEFINS

The increasing efforts on the part of foreign powers to attain self-sufficiency in motor fuels and lubricants has turned the attention of domestic petroleum refiners to the production of chemical by-products. Among the more important processes which have found commercial application is the synthesis of alcohols from the olefins in refinery gas. In the United States, during the year 1937, over half a billion gallons of gasoline were produced, more than half of which was manufactured by diverse cracking processes now in operation. Associated with this production was the evolution of over 500 billion cubic feet of gas containing 2 to 23 per cent ethylene and 5 to 18 per cent propylene. Although a part of this enormous quantity of gas is ultimately converted into gasoline by polymerization (eight million gallons in 1937), the greater part is used at the refinery as a gaseous fuel. As such its value is far less than that of the alcohol, ethyl and isopropyl, which could be produced by the hydration of ethylene and propylene, respectively. Although there is but one producer in this country manufacturing ethyl alcohol by the hydration technique, its share of the total production in 1937 was 15.2 per cent — a remarkable figure for a comparatively young enterprise.

The first reference to the hydration reaction was made more than a hundred years ago by Faraday. His contemporary, Hennell, produced both ethyl alcohol and ethyl ether by varying the conditions of the reaction. For this outstanding research Hennell is credited by many as having been fully as worthy of praise as Wohler for his synthesis of urea at about the same time. In 1897 Fritsche investigated the hydration of ethylene contained in coke-oven gas by means of concentrated sulfuric acid. He was the first to conceive of the industrial potentialities of the reaction; however, because the concentration of ethylene in the gas at his disposal was low and the recovery of acid incomplete, his results discouraged the industrial application of the process. With the rapid development of petroleum refining an impressive array of scientific talent was attracted by the possibility of converting the ethylene in refinery gases from straight-run stills, which averaged 18 per cent by volume, into ethyl alcohol. The results of numerous investigations made in the early 1920's indicated that concentrated sulfuric acid, 92 per cent or higher, served as an effective absorbent and hydrator of ethylene. More recent research has been concerned with the use of added catalysts and variations in operating conditions such as temperature, pressure, and contact time.

The industrial hydration of ethylene as conducted at present utilizes 98 per cent sulfuric acid as an absorbent. The fundamental reaction is as follows:

$$C_2H_4+H_2SO_4\rightarrow C_2H_5HSO_4 \qquad (1)$$

After having passed through the absorbing towers wherein reaction (1) occurs, the reaction mixture is diluted to approximately 35 per cent acid and subjected to a steam distillation whereby the ester is hydrolyzed and ethyl alcohol is carried off in the vapors. Thus:

$$C_2H_5HSO_4+H_2O\rightarrow C_2H_5OH+H_2SO_4 \qquad (2)$$

The dilute acid is then reconcentrated, brought up to

absorbing strength by addition of 100 per cent acid or oleum, and pumped back to the absorbers to repeat the cycle.

The economical application of this process is seriously limited by the necessity for dilution and subsequent reconcentration of the large quantity of acid which serves as the absorbent. Recovery of the alcohol directly from the reaction medium is not feasible because dehydration to ethylene and ethyl ether results. Because sulfuric acid and water form a constant boiling mixture 92 per cent by weight in acid, reconcentration is not carried beyond this point. Hence, with the completion of each cycle it is necessary to discard a portion of the "weak" acid equal to the weight of 100 per cent acid or oleum used in revivification. The ultimate utilization of such "weak" acid in the manufacture of some other product such as ammonium sulfate is essential for the economic success of the process. Worthy of mention is the fact that, as a consequence of the dilution procedure, power and steam costs represent an appreciable percentage of total expenditures.

The author is conducting an investigation of the hydration reaction in the high pressure laboratory of the Chemical Engineering Department at the Massachusetts Institute of Technology. In this research temperature, pressure, and acid concentration represent the prime variables. Particular attention is being directed toward the acid concentrations below 40 per cent with a view toward eliminating the costly dilution technique of the current industrial process.

A schematic diagram of the apparatus used in this work is presented in the adjoining figure. A mixture of ethylene and inert gas enters the reaction chamber by either of the inlet tubes and bubbles through the acid medium wherein some of the ethylene is hydrated. Under the experimental conditions which prevail any converted olefin immediately appears as alcohol in both the liquid and the gas phase. The alcohol which passes on in the gas is condensed in the water-cooled coil and collected in the receiver, the unconverted ethylene and inert gas passing on through the throttling valves and flow meters to a gas holder. The alcohol content of both the gas and liquid is determined periodically during the interval of time preceding and after the attainment of steady-state conditions. Experimental conditions cover a range of temperatures from 175 to 300 degrees Centigrade and of pressures from 100 to 200 atmospheres. By a variation of these conditions, together with such items as acid strength, acid volume, and gas rate and composition, the true character of the mechanism of reaction can be revealed. By a comparison of the actual conversion with that predicted by equilibrium data it will be possible to rate the relative efficiency of tests made under different experimental conditions, and thereby to arrive at the most practicable productive technique.

A. L. ANTONIO.

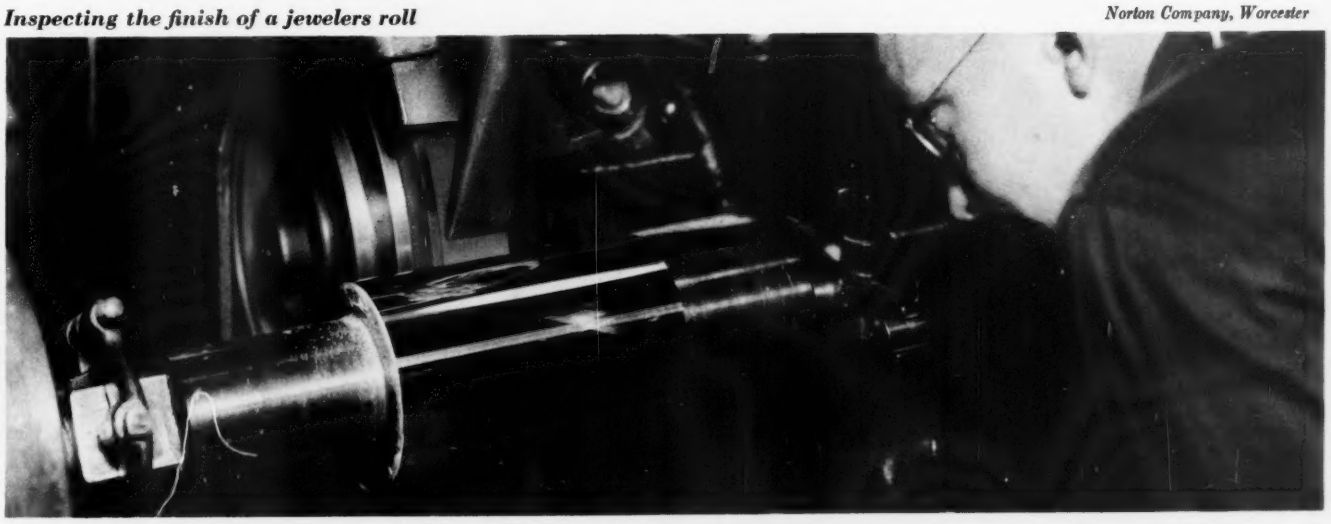
A. I. E. E.

The A. I. E. E., American Institute of Electrical Engineers, is a nation-wide organization of engineers active in the electrical field. The local Technology branch is conducted under the head of Walter K. Halstead, '39, and is associated with the Combined Professional Societies of the Institute. This branch is endeavoring to acquaint the students registered in the Electrical Engineering courses with the methods and demands of industry. This is done by meetings with engineers active in the field and by means of field trips.

Plant trips for the earlier months of the school year were to Lever Brothers and the Western Union Cable Ship, the *Lord Kelvin*. The first meeting of the year was chiefly for the purpose of acquainting new members with the organization, and featured talks by Professor W. H. Timbie, Department of Electrical Engineering, Professor A. A. Schaefer, Department of Business and Engineering Administration, and Mr. E. Dana, President of the Boston Elevated Railway Co. Mr. R. G. Slauer of the Westinghouse Co. spoke at the second meeting. His subject was "New Light Sources" and was accompanied by demonstrations. The third meeting, also held at the Institute, very fittingly co-ordinated the work of the Boston student chapters at Harvard, Tufts, Northeastern and Technology. Mr. John G. Parker, National President of the A. I. E. E., was the principal speaker, his subject being, "Undergraduate Study and the Job." Subjects of the last meeting of the year were student talks, among them being "Electronic Musical Instruments," presented by G. D. Hulst, Electrical Engineering senior and contestant for the Stratton Prize.

R. KOCHENBURGER.

Inspecting the finish of a jewelers roll — *Norton Company, Worcester*



AUTOMOBILES OF 1939

(*Continued from page 190*)

the pressure ventilating and heating system introduced by Nash. This year, many cars have similar systems, and by introducing fresh air under slight pressure, body moisture, stale air, and smoke are forced out, and exhaust gas and engine fumes cannot be drawn into the bodies. This is one of the greatest contributions to comfort and safety that has ever been offered. The built-in direction indicators, by which the driver can indicate to a motorist in the rear which way he is going to turn, will soon be necessary on cars equipped with pressure ventilating systems, as no driver will want to open a window in inclement weather to give hand signals. These direction indicators have been compulsory in Europe for years and have been introduced this year by the Buick Company in the United States.

Several years ago the Willys-Knight Company showed that there was a market for an economy car. Ford then followed with the 60 model, and this year there are many cars that sacrifice flashy performance for economical operation. This year the constant increase in engine compression ratios seems to have temporarily halted. Fewer aluminum cylinder heads are used, and ferrous oxide coated piston rings and tin plated aluminum pistons are being widely used. In many engines, cooling fans are now mounted on the crankshafts and act as vibration dampers. One of the greatest improvements from a safety standpoint has been the adoption of corrosion resisting metals for the exhaust systems and the use of heavier gage metal.

For several years overdrives have been used with varying degrees of success. They would automatically cut in and out at predetermined speeds, their greatest asset being the increased fuel economy at high speeds. This year overdrives have a "stamp out" control to overcome previous difficulties. When the driver wishes quick acceleration, he pushes the throttle to the limit and a solenoid control cuts out the overdrive and engages the direct drive, thus giving the driver full control of his transmission. Many cars offer different rear axle ratios. If the purchaser is interested in quick pick-up, he can obtain it at the expense of fuel and oil economy, while other buyers can have the same car with less acceleration and better fuel economy. The Oldsmobile is again offering their automatic transmission as an optional feature. As further modernization of the rear axle assembly, hypoid gears are being generally used to allow the floor to be lowered.

Riding comfort is being given close attention in the 1939 cars. Independent front wheel springing is again gaining popularity, the geometric layout of the system being improved in order to make steering easier and give greater control. In these independent wheel suspensions rubber bushings are being used in increasing numbers. On all cars, leaf springs have been improved by better control of interleaf friction. The use of progressive leaf springs makes possible the handling of both light and heavy loads with ease. This year the use of coil springs all around has been adopted by Oldsmobile, following their introduction by Buick last year. In many spring suspensions the car has been given a higher center of roll, thus holding the road better. Torsion stabilizing bars are likewise in use this year to prevent roll, while some cars employ radius rods from the rear axle to the rear frame.

Slow steering, that is a maximum angle of steering wheel rotation for a minimum of actual turning, is still being used on this year's models. It is a selling point as an aid to parking and as a safety factor at high speeds, preventing quick movements of the wheels. This feature may also be dangerous in slippery weather, however, as it prevents the necessary quick response of the wheels to check skids.

Many other new features have also appeared this year. The newer buses have true air-conditioning systems. They also are using a highly developed type of hydraulic torque converter in place of the gear or elec-

(*Continued on page 203*)

RADIO

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AUTOMOBILES OF 1939

(*Continued from page 202*)

tric transmissions. The cotton fibre tire has become practical, its development being spurred on by the appearance of the original rayon tire a year ago. The Diesel engine has become a serious competitor for the carburetted engine in the truck field, being offered as replacements on some gasoline powered trucks.

Thus the modern automobile is again returning to safety, comfort, and efficiency. By the use of new materials, the refinement of details, and return to functionalism the automobile is becoming a better vehicle. At the same time, manufacturing processes are being improved so that better cars can be sold at prices no higher, and often lower, than previous models.

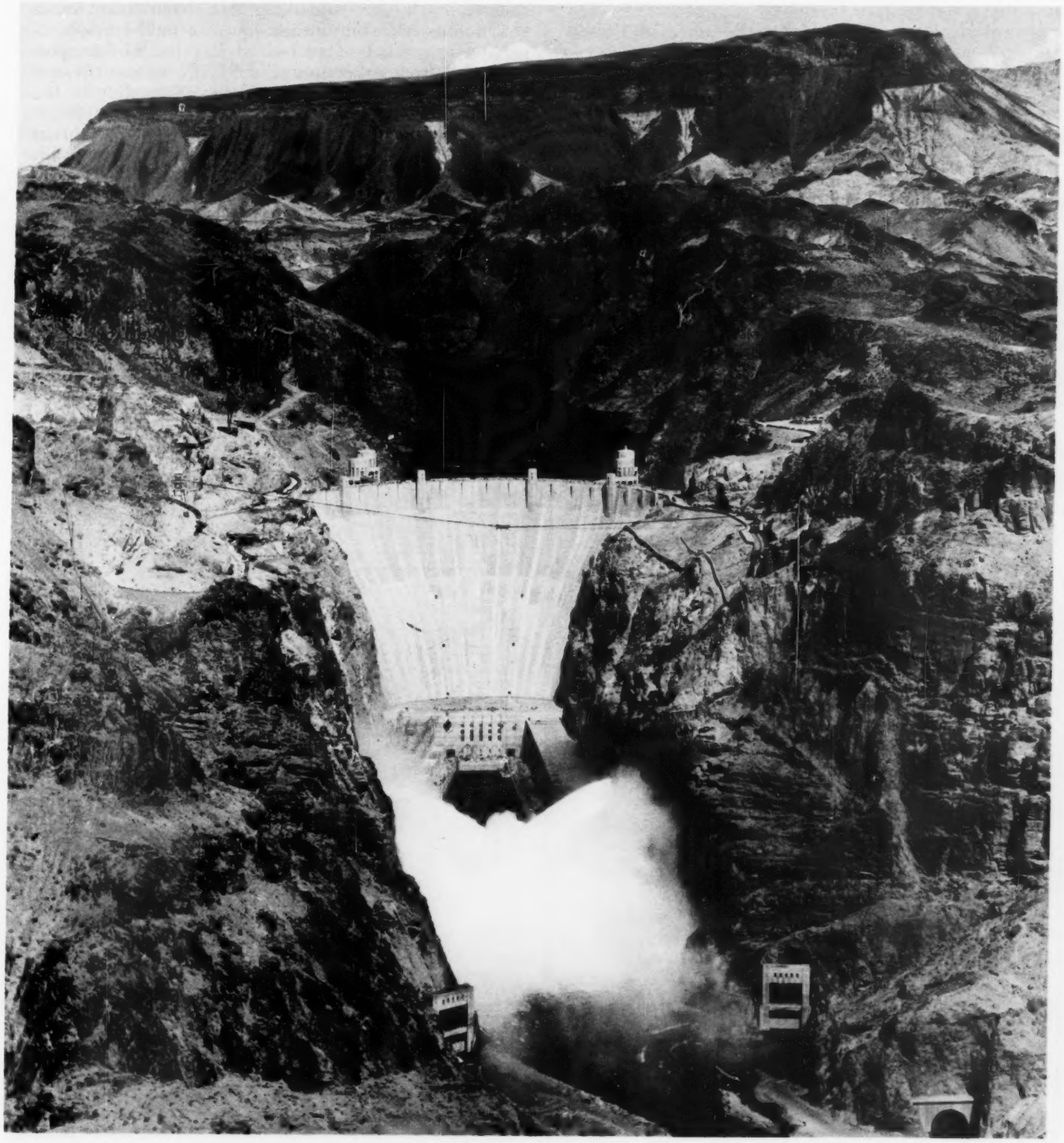
PHOTOGRAPHY AND METALLURGY

(*Continued from page 192*)

determine not only what an alloy contains but how much.

In addition to these direct and obvious uses of photography by the metallurgist many indirect uses of photographic methods have added materially to our present knowledge. Such methods are widely used in the detection and measurement of slight changes in temperature, elongation, creep or damping in metals and alloys.

It is safe to say that no single factor has contributed more to the change of metallurgy from the art of the early days to the science of today than has photography with its many applications.



THE COMMON COLD

(*Continued from page 195*)

reading being the systolic pressure and the lower reading the diastolic pressure. Curve E represents the pulse rate; F, the body temperature; G, the respiratory rate; and H and I represent in order the blood pH and the blood CO_2 content. Curve J is the curve of the daily leucocyte count. Curves K and L show the variations in the blood potassium and blood calcium. The four numbers correspond to the four systolic blood pressure peaks, and the arrows down the curve indicate the first day of the clinical symptoms of the cold. Curves A through C indicate respectively the barometric pressure in inches, the maximum and minimum temperature with the band showing the temperature range, and the noon relative humidity in percentage. The meteorological records are from the office of United States Weather Bureau in Chicago.

Before we examine the day the cold began, let us look at the general biometeorological significance of the accompanying diagram. We note at the onset that on each day that the author showed a systolic blood pressure crest, there was a corresponding barometric pressure crest. Immediately following the systolic crest there was a diastolic minimum in every case. This pendulation of the blood pressure corresponds to vasoconstruction and vasodilation. In other words, with each in-break of the cold air the author had a vascular spasm which was followed by vascular dilation. Each spasm was associated with a relative alkalosis (except on the day the cold occurred), and each vascular dilation is associated with a relative acidosis or fall in the blood pH. As we would expect, the blood pH is the inverse curve of blood CO_2. Petersen has called the biochemical rhythm the ARS phase and the COD phase. The ARS phase is a period of relative alkalosis, resistance, and spasm, while the COD phase is a period of vascular permeability, acidosis, and dilation. These two phases are very important in connection with the initiation of disease, infection, and dysfunction. The biochemical curves certainly show that status of the author was by no means a stable affair.

On July 25, Chicago experienced a rather violent thunderstorm. Accompanying this storm there was a sharp, almost instantaneous, increase in the barometric pressure of 0.1 of an inch at 10 p.m. The temperature fell from a maximum of 91° F. on the twenty-fifth to 71° F. on the twenty-sixth. According to the author's notes, he had a sore throat late the night of the twenty-fifth. On the twenty-sixth the sore throat continued and a cough developed. The author felt tired and stiff because of an increase in the body temperature. The high body temperature continued for about eight days and then returned to normal. The cough lasted for three weeks.

From the biological standpoint we find that the sore throat was the result of vascular spasm accompanying

(*Continued on page 205*)

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THE COMMON COLD

(*Continued from page 204*)

the sudden cooling of the air and the sharp rise in barometric pressure. The infectious agent began its invasion as shown by the rapid increase in the white blood count (J). During vasodilation the invasion continued. The sharp increase in the amount of potassium and calcium indicates some extreme biochemical fluctuations had taken place. As the virulence of the invading organisms was reduced by the leucocytes, the calcium and potassium returned to normal, and the leucocyte count diminished in proportion to the need for their protective ability. The tiring effect of the heat and humidity lowered the blood pH to a relatively acid level. The cold occurred when the pH had begun to return to a relatively alkaline level, but its rise was retarded by the COD phase. As the body adjusted itself and returned to a normal condition, the pH became more and more alkaline. Thus we have seen how the normal biochemical rhythm was considerably altered by the excessive heat and humidity so that when a sudden chilling of the atmosphere took place with the in-break of polar air, a cold resulted, and the change produced a significant reaction of the whole body.

The author's case is only one of many such cases. Petersen has shown that the cold is initiated at the cold front by the pressor episode (ARS phase). At this time there is consistently an increase in the blood pH and a decrease in the blood CO_2. The author's case is but an ARS accentuation, typical of most onset symptoms of infections of the upper respiratory tract. In a three year study of the incidence of colds at the Phillips Exeter Academy, the author found that most of the colds appeared within twelve to twenty-four hours following the cold front. All these facts point to the same conclusion. The onset time of the cold is closely related to biochemical status of the individual, which in turn is closely related to the meteorological environment of the individual.

We begin to see at last that the biochemical condition of the human body and the state of the atmosphere play an exceedingly important role in the etiology of the infections of the upper respiratory tract. In fact, we may add without misgivings that the ARS-COD pendulation and the progression of fronts across the continent play some role in determining the onset time of all dysfunctions and diseases of the body, if not even a small part in their etiology. This fact is not fully recognized nor fully appreciated by the medical profession, first, because the relationships are often obscure; and, second, because many medical doctrines do not include such a possibility. It will be the problem of the future to elucidate meteorobiology and its relation to the problems of modern medicine.

U. S. Bureau of Reclamation

THE NATIONAL STANDARD OF FREQUENCY

(*Continued from page 194*)

radio-frequency emissions may be used for many purposes, the most common being to determine accurately the frequency of a standard oscillator. The apparatus necessary consists of the oscillator, a continuously variable radio-frequency generator which has been approximately calibrated, a variable audio-frequency generator, and a regenerative radio receiving set. The fundamental frequency of a piezo oscillator is determined by the dimensions of the quartz plate. The usual vacuum tube circuit arrangement in which the quartz plate is connected gives, as we have already stated, numerous harmonics for each fundamental frequency. The radio generator, which is continuously variable, can be adjusted to any frequency, and likewise gives a series of harmonics for each fundamental frequency for which it is adjusted. If the frequency of the radio generator is varied over a wide range, beat notes are produced at a number of settings of the generator by the interaction of the various harmonics of the fundamental frequency of the piezo oscillator with an harmonic of the fundamental frequency of the generator. The beat notes may be heard in a pair of earphones connected to the generator or to the piezo oscillator. Any frequency present in the piezo oscillator can beat with a corresponding frequency present in the radio generator. This makes it possible to set the generator at a number of frequencies having a simple relation to the fundamental frequency of the piezo oscillator. It is obvious, therefore, that if the harmonic relationship is known, measurements can be made at a great number of frequencies in terms of a single standard frequency.

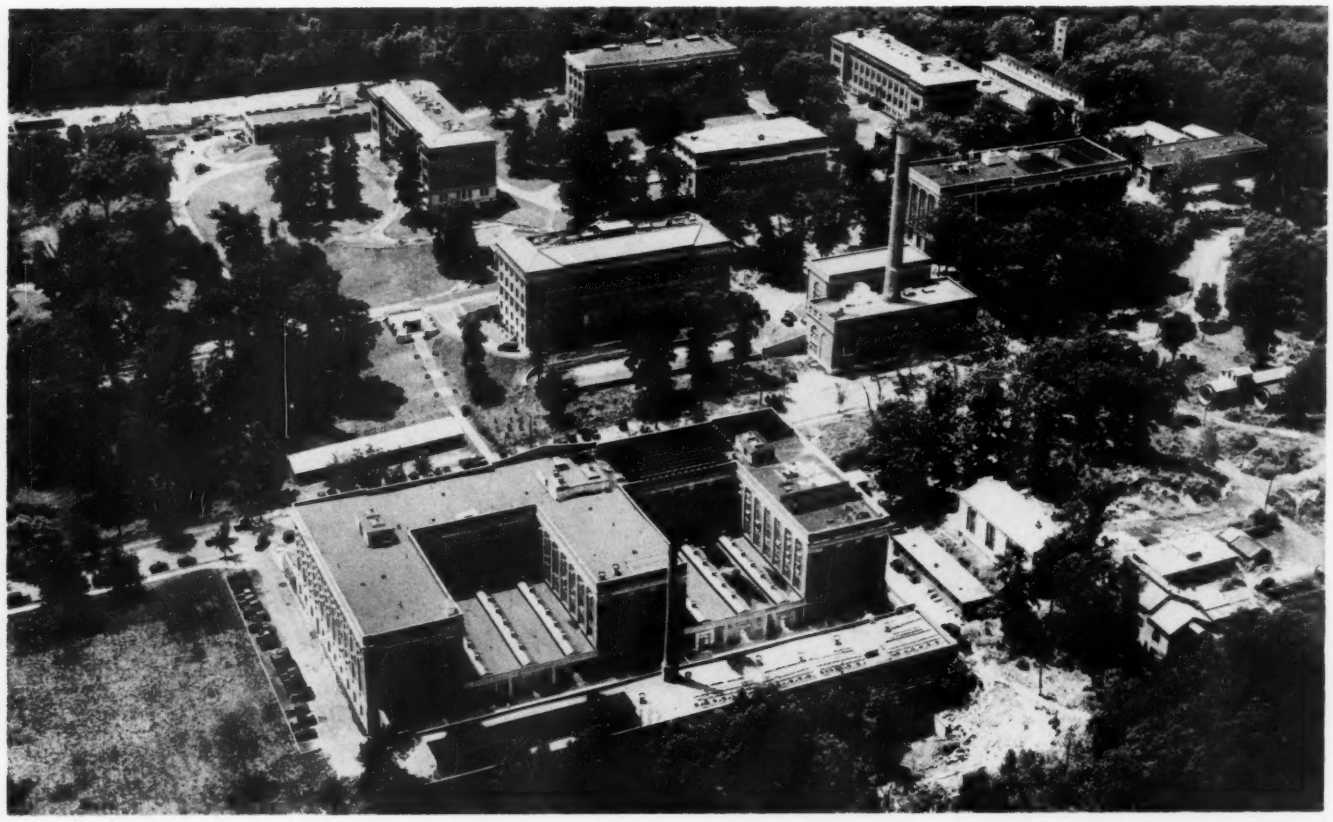
Naturally, the frequencies which are integral submultiples of the emission frequency are most easily measured. Only two broadcast frequencies, 1,000 and 1,250 kilocycles, bear this relation to the 5,000 kilocycles standard frequency. If a 1,000-kilocycles oscillator, whether a transmitting set or frequency standard, is coupled to a radio receiver tuned to 5,000 kilocycles at the time the standard signal is being received, a heterodyne note will be produced which is equal to the frequency difference between the fifth harmonic of the 1,000-kilocycles oscillator and the standard signal. If the nominal value of the 1,000-kilocycles oscillator is known, all that remains in order to measure the frequency accurately is to determine the frequency of the beat note, and whether the unknown frequency is higher or lower than the standard frequency. The same principles that apply to the 5,000-kilocycles standard frequency may be followed for the 10,000- and 20,000-kilocycles emissions.

Measurements of frequencies which are submultiples of 50 require the use of an auxiliary generator in addition to the high frequency receiver. The generator may be a piezo oscillator, or it may be a manually controlled oscillator, but the former is to be preferred if it is available. In this case, a distorting amplifier is necessary in order to bring out the harmonics so that the beat between them and the standard signal can be easily heard.

The methods of measurement just described are applicable to twenty of the frequencies in the broadcast band. The highest common factor of 5,000 and the remainder of the broadcasting frequencies is ten. The frequency of the auxiliary generator must, therefore,

(*Continued on page 207*)

The National Bureau of Standards — *Photograph by Army Air Corps*



THE NATIONAL STANDARD OF FREQUENCY

(*Continued from page 206*)

be ten kilocycles, if these other broadcast frequencies are to be checked readily in terms of the 5,000-kilocycles emissions. As the beat note between the 500th harmonic of the ten-kilocycles generator and the 5,000-kilocycles emissions is not loud enough to be heard distinctly, the simplest solution is to set the auxiliary generator on 100 kilocycles and let it control a ten-kilocycles multivibrator. The standard frequency signal can then be heard easily, and the harmonics of ten kilocycles will heterodyne equally well with frequencies in the broadcast band. With this equipment, all assigned broadcast frequencies can be checked against the 5,000-kilocycles standard frequency signal.

Once a week the Bureau's standard frequency emissions are modulated by an audio frequency of 1,000 cycles per second. This service, which does not interfere with the use of the carrier frequency as a standard, may be utilized with very simple equipment. Any receiving set capable of picking up the signals will deliver the standard audio frequency at the output terminals. This frequency may be used for comparison with a local frequency, thus accurately measuring the latter for control of some type of frequency standard, or for the production of an accurate standard of time rate. By the use of harmonic amplifiers, or multivibrators, to multiply or divide either the incoming standard frequency, the local frequency, or both, measurements may be made very conveniently as well as accurately.

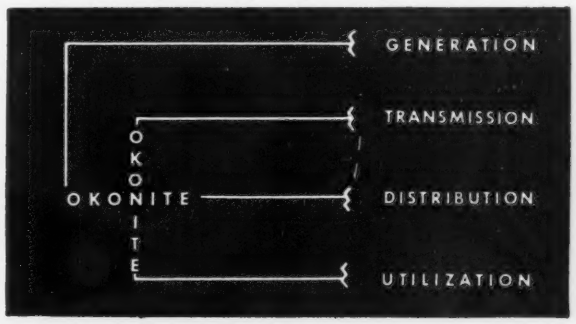
The standard intervals of one second, provided by the Bureau twice each week, are accurate to better than 0.00001 second. Taken over a longer period of time, this figure may be divided by the number of seconds duration of the time interval considered up to a limit of one part in 5,000,000; that is, under ideal receiving and measuring conditions it should be possible to measure a time interval of 50 seconds or longer to better than one part in 5,000,000. However, measurements of 0.00001 second are difficult to make, and a longer time interval than 50 seconds would ordinarily be required to obtain a certainty of one in 5,000,000. A limitation is also placed on the accuracy by the vagaries of radio wave transmission. The most accurate time intervals are provided at any place or time by that one of the three carrier frequencies which has the least fading.

The most recent addition to the Bureau's services and one which has proved of great popular interest is the broadcasting each day, except Saturday and Sunday, from 4 p.m. to 1 a.m. (E. S. T.) of the American standard of musical pitch, 440 cycles per second. This pitch is for "A" above middle "C." Although this service is intended primarily for musicians, it has been found useful to laboratories in ways similar to the previously described audio-frequency emissions. An announcement is made by voice, and the call letters, WWV, of the Bureau's station at Beltsville, Maryland, are given in Morse code every ten minutes, starting on the hour. The radio frequency is 5,000 kilocycles, and the power is one kilowatt with 100 per cent modulation.

A short wave or all wave radio receiving set is necessary to pick up the A tone, since the radio carrier frequency is much higher than the well-known frequencies on which the usual broadcast entertainment programs are given. The broadcast receiving sets sold previous to 1937 will not receive this high frequency, but most of the receiving sets now being sold will do so. The dial-scale should be set for five megacycles in order to receive the standard A broadcasts. For satisfactory reception, considerable care must be used in the tuning of the receiver, because a slight adjustment at higher frequencies changes the tuning by a large amount.

After thus describing very briefly the standard frequency service which the Bureau now provides, it is interesting to note how rapidly the necessity for frequency standards has developed. Thirteen years ago, when quartz oscillators were first used experimentally for the control of radio frequencies, it was predicted that standard frequency transmissions might be sent out that would be good to one part in 10,000. Such precision seemed beyond probable needs, but with the rapid advances in radio design and technique, it was soon inadequate. Today, the Bureau's transmissions are accurate to one part in 5,000,000. As we look ahead, the difficulty which faces us is the finding of a primary standard of time sufficiently constant and precise to warrant a still higher degree of accuracy in the determination of frequency. Our standard of time is not invariable; the earth wobbles on its axis; the moon affects the tides and the pendulums of clocks. It seems probable that some entirely new time standard will come into use that will bear the always-to-be-desired relationship of "one decimal place better than the derived standard."

THE 4-ø ELECTRICAL SYSTEM



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G-E Campus News

RAINBOW-COLORED COURTS

SAN FRANCISCO built the island—now, General Electric is lighting it in all the colors of the rainbow.

The lighting of the Golden Gate International Exposition, which will open in February on man-made Treasure Island in San Francisco Bay, will be the most colorful ever undertaken. For it will illuminate in all the rainbow's colors the many buildings and beautiful "courts" on the island—the Court of the Moon, the Court of the Seven Seas, and others. More than 9000 floodlights are being used. The illumination is under the direction of A. F. Dickerson, Texas A. and M. 1910, Manager of the General Electric Illuminating Laboratory, at Schenectady.

The "rainbow of light" for the San Francisco Fair will be another in a series of General Electric lighting projects that have illuminated Chicago's Century of Progress, Brazil's Centennial Exposition, the Texas Centennial, and others. And as G-E engineers develop the project for San Francisco, again they are being aided by recent engineering college graduates and ex-Test men—the men who will design the brilliant exposition lighting of the future.

OPPORTUNITY FOR RESEARCH

SELECTED graduates of American colleges carry on research work each year in chemistry, physics, and physical chemistry with the aid of Charles A. Coffin Foundation Fellowships. These fellowships were established by General Electric in 1922 in honor of the Company's first President, Charles A. Coffin.

The awards are made by a committee of distinguished men. This year the committee consists of Dr. Bergen Davis, representing the National Academy of Sciences; Dr. Karl T. Compton, of the Society for the Promotion of Engineering Education; and Dr. John C. Parker, of the American Institute of Electrical Engineers. The candidates' applications, together with the faculty recommendations forwarded to General Electric by the various colleges, are the basis for the awards.

This year, applications for the fellowships must be in the hands of the Secretary of the Charles A. Coffin Foundation Committee, at Schenectady, on January 15, 1939.

HAWAII IN NEW YORK

TWO men sat down at a table recently and decided to air-condition Hawaii.

But they weren't concerned with changing the atmosphere above Diamond Head Mountain or the "Beach at Waikiki." Their problem was centered in Manhattan; "Hawaii" is the Hawaiian Room of New York's Hotel Lexington, where a 120-ton G-E air-conditioning system is being installed. Not only will it assure greater comfort for the patrons, but it will preserve an Hawaiian atmosphere—heretofore the atmosphere varied with New York's seasons.

The many Test men and ex-Test men assigned to air-conditioning work are ever seeking new applications for this G-E equipment. The results of their efforts can be seen in all parts of the country. Cliff House in San Francisco, overlooking the famous Seal Rocks, recently made its air-conditioned debut. "The Cradle," haven of homeless infants in Evanston, Illinois, is being similarly equipped, the equipment aiding in protecting the babies against infection by air-borne germs.

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